STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

COLLECTION AND INTERPRETATION OF INFORMATION NEEDED TO SOLVE SPECIAL MANAGEMENT PROBLEMS

by

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Section F

Job No. G-I-S Page No.

Collection and Interpretation of Information Needed to Solve Special Management Problems — Artwin Schmidt

Section F

RESEARCH PROJECT SEGMENT

State: ALASKA

Name: Sport Fish Investigations of Alaska

Project No.: F-9-10

Study No.: G-I

Study Title: INVENTORY & CATALOGING

Job No.: G-I-S

Job Title: Collection and Interpretation of Information Needed to Solve Special Management Problems

Period Covered: July 1, 1977 to June 30, 1978

ABSTRACT

Due to the specialized nature of the investigations being carried on under Job No. G-I-S, a separate section is devoted to each of the job objectives.

Section I

Additional or new information was received and filed on 57 streams and 22 lakes in southeast Alaska. This included data on fish species and abundance, population dynamics, biological surveys, and recreational surveys. Effort was devoted to acquiring copies of research and management data collected by other biologists.

Section II

A study was conducted on the Keta River between June and November 1977 to determine important spawning and rearing areas for salmon which might be impacted by road construction. Detailed maps of the river were drawn to include tributaries, side channels, sloughs, upwelling areas, and beaver ponds. Physical features of the stream including water depth, stream width, pools, riffle areas, logs, and bank type were noted.

Distribution of rearing and adult salmonids was determined by fry trapping, riverboat surveys, and aerial surveys.

The final location of the road had not been staked, so no calculations of habitat loss were possible. While little physical displacement of fish habitat is planned, the potential for habitat degradation due to siltation and road failure is high.

Section III

Limnological and fishery investigations were conducted on four lakes currently being considered for hydroelectric development in the Wrangell and Ketchikan areas. The fishery and recreational potential of each lake was evaluated with respect to how it would be affected by development.

Virginia Lake near Wrangell is a high use recreation area with excellent cutthroat trout, *Salmo clarki* Richardson, fishing and a unique run of small sockeye salmon, *Oncorhynchus nerka* (Walbaum). Development of this system would have definite detrimental effects. It is recommended that Virginia Lake not be developed if a suitable alternative can be found.

Of the three lakes being considered for hydroelectric development in the Ketchikan area, development of Swan Lake would have less effect than development of Grace or Mahoney lakes.

OBJECTIVES

1. To continue collection, analysis, and organization of all available and new information on sport fish resources of individual lakes, streams, and saltwater areas in southeast Alaska.

2. To determine spawning and rearing areas of the Keta River system which could be adversely impacted by development of a road to the proposed U.S. Borax mine.

3. To evaluate the fishery potential of lakes which are being considered for hydroelectric projects.

SECTION I

OBJECTIVE

To continue collection, analysis, and organization of all available and new information on sport fish resources of southeastern Alaska.

BACKGROUND

The Inventory and Catalog File was created to provide a library for the collection of reports of management actions, research data, development plans, and other information of interest for each aquatic system in southeast Alaska. This file is maintained in duplicate in Juneau and Sitka Department of Fish and Game offices. It was organized in 1972 (Schmidt and Robards, 1973) to facilitate the dissemination of information to resource agency personnel and the interested public.

RECOMMENDATIONS

1. Collection, analysis, and organization of available new information on sport fish resources in southeast Alaska should be continued.

2. A computerized filing system should be started which would: (a) provide identifying numbers for each lake and stream in southeast Alaska, (b) list types of information available for each system, (c) give date of most recent entry, (d) give location of information, and (e) allow for annual updating of computer listing by all agencies using system.

TECHNIQUES USED

New and additional information was received and filed under the system described by Schmidt and Robards (1973). Other researchers were contacted, and copies of their recent fieldwork were requested and received. Information was added to our files on the following systems:

Lake	Latitude, Longitude	Location
Alecks Lake	56°31'30" N, 134°01'00" W	Kuiu Island
Barren Lake	59°30' N, 139°09' W	Yakutat
Big Pine Lake	59°30' N, 139°09' W	Yakutat
Essowah Lakes	54°47' N, 132°52' W	Dall Island
Finger Lake	55°57' N, 133°06' W	Prince of Wales Island
Grace Lake	55°38' N, 131°03' W	Revilla Island
Green Lake	56°59'45" N, 135°05'30" W	Baranof Island
Image Lake		
Moss Lake	56°55' N, 133°12' W	Prince of Wales Island
Neck Lake	56°06' N, 133°11' W	Prince of Wales Island
Pond No. 1	59°29' N, 139°12' W	Yakutat
Pond No. 3	59°29' N, 139°12' W	Yakutat
Raven Lake	55°59'48" N, 133°08'06" W	Prince of Wales Island
Red Lake	56°15' N, 133°19' W	Prince of Wales Island
Redfield Lake	59°38' N, 139°32' W	Yakutat
Sarkar Lake	55°57' N, 133°13' W	Prince of Wales Island
Spare Lake		Prince of Wales Island
Square Lake	59°13' N, 138°43' W	Yakutat
Tammy Lake	55°59' N, 133°13' W	Prince of Wales Island
Tanis Mesa No. 1	59°14' N, 138°32' W	Yakutat
Taylor Lake	59°29' N, 139°09' W	Yakutat
Unnamed Lake	59°16' N, 138°38' W	Yakutat

Stream	Stream No. or Latitude, Longitude	Location
Akwe Lake Inlet	59°20' N, 138°47' W	Yakutat
Akwe River	59°14' N, 138°49' W	Yakutat
Alecks Creek	56°30'12" N, 134°02'18" W	Kuiu Island
Anna Lake Creek	57°38' N, 136°03' W	Chichagof Island
Big Goose Bay Head	112-48-12	Chichagof Island
Cannery Creek	59°09' N, 138°39' W	Yakutat
Crab Bay	112-43-12	Chichagof Island
Crab Bay South Tidal Flats	112-43-02	Chichagof Island
Didrickson Lake North	57°51' N, 138°22' W	Chichagof Island
Didrickson Lake South	57°51' N, 138°22' W	Chichagof Island
Doame River	59°51' N, 138°22' W	Yakutat
Eaton Creek	112-45-32	Chichagof Island
Eighteen Mile Creek	59°31' N, 135°15' W	Yakutat
Emile Creek	59°12' N, 138°28' W	Yakutat
Eva Lake Creek	57°24'00" N, 135°06'30" W	Baranof Island
Freshwater Bay Head	57°51' N, 134°59' W	Chichagof Island
Game Creek	50°04'40" N, 135°28'36" W	Chichagof Island
Gartina Creek	58°05'31" N, 135°25'16" W	Chichagof Island
Gypsum Creek	57°58'51" N, 134°58'55" W	Chichagof Island
Harlequin Lake Inlet	59°28' N, 138°59' W	Yakutat
Hoktaheen Creek	58°04'20" N, 136°32'30" W	Yakobi Island
Humpback Creek	59°38' N, 139°35' W	Yakutat
Italio River	59°17' N, 139°05' W	Yakutat
Kadake Creek	109-42-030	Kuiu Island
Kalinin Bay Creek	57°18' N, 135°47' W	Kruzof Island
Karheen Creek	55°48' N, 133°19' W	Tuxekan Island
Karta River	55°33'45" N, 132°34'30" W	Prince of Wales Island
Klag Bay Creek (cabin)	113-72-02	Chichagof Island
Little Goose Creek	57°56'13" N, 135°49'06" W	Chichagof Island
Long Bay Head	112-47-10	Chichagof Island
Medvetcha River	57°02'50" N, 135°13'35" W	Baranof Island
Miller Creek	59°27' N, 139°06' W	Yakutat
Noxon Creek	113-42-03	Baranof Island
Old Situk Creek	59°34' N, 139°25' W	Yakutat
Red Bluff Bay Creek	56°50'30" N, 134°42'00" W	Baranof Island
Redfish Bay Creek	56°19' N, 134°52' W	Baranof Island
Saltery Bay Head	112-44-10	Chichagof Island
Seagull Creek	58°00'57" N, 135°33'24" W	Chichagof Island
Seal Creek	57°56'01" N, 135°09'03" W	Chichagof Island
Seal Bay Head	112-46-10	Chichagof Island
Seal Bay Southwest Head	112-46-09	Chichagof Island
Sinitsen Creek	113-62-08	Kruzof Island
Sitkoh Lake Creek	57°30'30" N, 135°05'00" W	Chichagof Island
Situk River	59°27' N, 139°34' W	Yakutat
Sockeye Creek	59°28' N, 139°09' W	Yakutat
Starrigavan Creek	57°13' N, 138°39' W	Baranof Island
Suloia Bay Creek	57°08'00" N, 135°22'30" W	Chichagof Island
Tanistay River	59°13' N, 138°41' W	Yakutat
Tawoh Creek/Lost River	59°28' N, 139°37' W	Yakutat

Stream	Stream No. or Latitude, Longitude	Location
Tenakee Inlet Head	58°00'10" N, 135°53'58" W	Chichagof Island
Trail River	58°03'48" N, 136°06'17" W	Chichagof Island
Twentyone and One-half Mile Creek	59°29' N, 139°12' W	Yakutat
Twentytwo Mile Creek	59°28' N, 139°11' W	Yakutat
Twentytwo Plus Mile Creek	59°29' N, 139°10' W	Yakutat
Unuk River	56°05' N, 131°05' W	Yakutat
Williams Creek	59°10' N, 138°34' W	Yakutat
Wukuklook Creek	57°55'25" N, 134°56'17" W	Chichagof Island

SECTION II

OBJECTIVE

To determine spawning and rearing areas of the Keta River system which could be adversely impacted by development of a road to the proposed U.S. Borax mine.

BACKGROUND

In March 1976 U.S. Borax and Chemical Corporation announced their expanding interest in a molybdenum deposit at a 1-square-mile site 72.4 kilometers (45 miles) east of Ketchikan. The mineral deposit is located on Quartz Hill, which lies between Wilson Arm and Boca de Quadra.

Construction of a mining complex in the Wilson Arm and Boca de Quadra areas of southeastern Alaska has the potential of influencing three major salmon spawning streams and their estuarine tidal flats. Two of these streams, the Wilson and Blossom rivers, are located in Wilson Arm and the third, the Keta River, in Boca de Quadra. The streams are, for the most part, characterized by clear, cold water and are subjected to large variations in discharge. In the spring, runoff from Keta and Blossom rivers can be silty due to glacial activity. During winter the streams are sometimes ice covered; however, ample discharge occurs throughout the year for salmonid survival. In summer, snowmelt maintains streamflows during periods of drought.

Depending on the location of the access road and additional mine-related developments, one, two, or all three of these major salmon producing streams will be affected. The Alaska Department of Fish and Game has recommended that all mining activities be confined to Boca de Quadra because of the greater fish and wildlife resources associated with Wilson Arm.

In 1977 U.S. Borax requested permission to build a road along the Keta River from salt water to Quartz Hill. Due to topography this road would travel immediately adjacent to the river. The possibility exists for alteration of spawning and rearing habitat, depending on the final location of the roadbed.

In order to make recommendations for location of this road it was necessary to determine the spawning and rearing areas within the Keta River. Between March and November 1977 the system was surveyed for spawning and rearing areas. This report presents the results of that study.

RECOMMENDATIONS

Management

1. Final road location should be determined through Interdisciplinary Team surveys with U.S. Forest Service.

2. The amount of habitat loss due to road construction and maintenance, if road is constructed, should be determined.

3. A plan should be developed for possible mitigation of lost fish habitat.

4. A spring survey of lower Keta River should be conducted to determine distribution of and use by Dolly Varden, Salvelinus malma (Walbaum), and steelhead trout, Salmo gairdneri Richardson.

5. A fall survey should be conducted to determine distribution of spawning coho salmon, Oncorhynchus kisutch (Walbaum), and Dolly Varden.

6. The present aerial survey programs for pink, O. gorbuscha (Walbaum), chum, O. keta (Walbaum), and chinook salmon, O. tshawytscha (Walbaum), should be continued with emphasis on spawning distribution below Hill Creek.

TECHNIQUES USED

This study was conducted on June 2 and 3 and July 18 through August 19 on the Keta River in Boca de Quadra. Emphasis of study was placed in areas where the proposed road approached the river between tidewater and the Hill Creek tributary, 6.6 kilometers (4.1 miles) upstream.

Detailed maps were drawn of the Keta River noting side channels, sloughs, beaver ponds, and tributaries. Physical features of the stream including water depth, stream width, pools, riffle areas, logs, and bank type were noted.

Fish distribution was determined for young fish by capture with baited minnow traps and by visual observation. Each trap was baited with Boraxed salmon roe and set for one-half to two hours. Fish captured were identified and counted.

Distribution of chinook salmon from the mouth of the Keta River to just below Back Creek was noted weekly by riverboat between July 22 and August 19. A peak escapement count was obtained by the "King Salmon" project leader during an aerial survey on August 17.

Counting pink and chum salmon by riverboat was difficult due to the width of the spawning areas and their scattering and mixing with each other on the spawning areas. Commercial Fisheries Division estimated numbers of pink and chum salmon by aerial survey.

FINDINGS

Map of Keta River

Figure 1 shows an overview of the Keta River and the locations of the seven sections of stream shown in Figures 2 through 8. These figures show the main channel of the Keta River, side channels, tributaries, areas

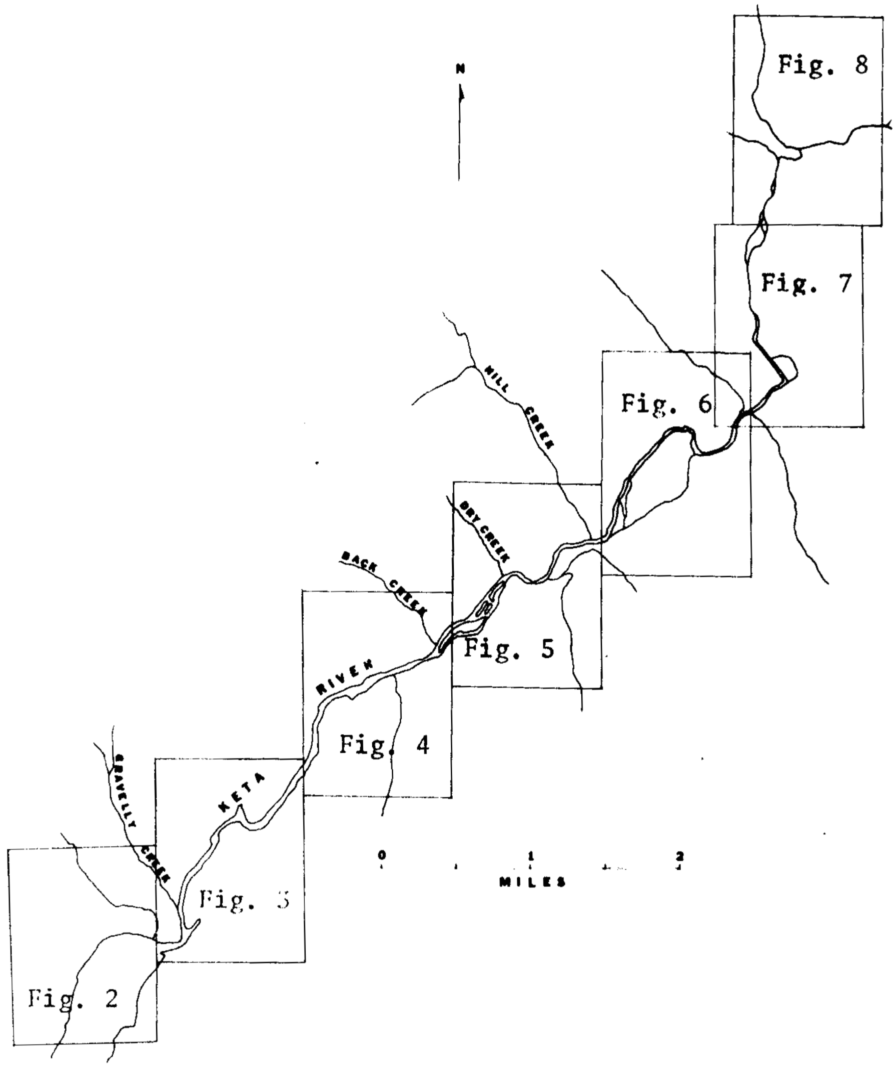


Figure 1. Overview of Keta River showing seven sections mapped in 1977.

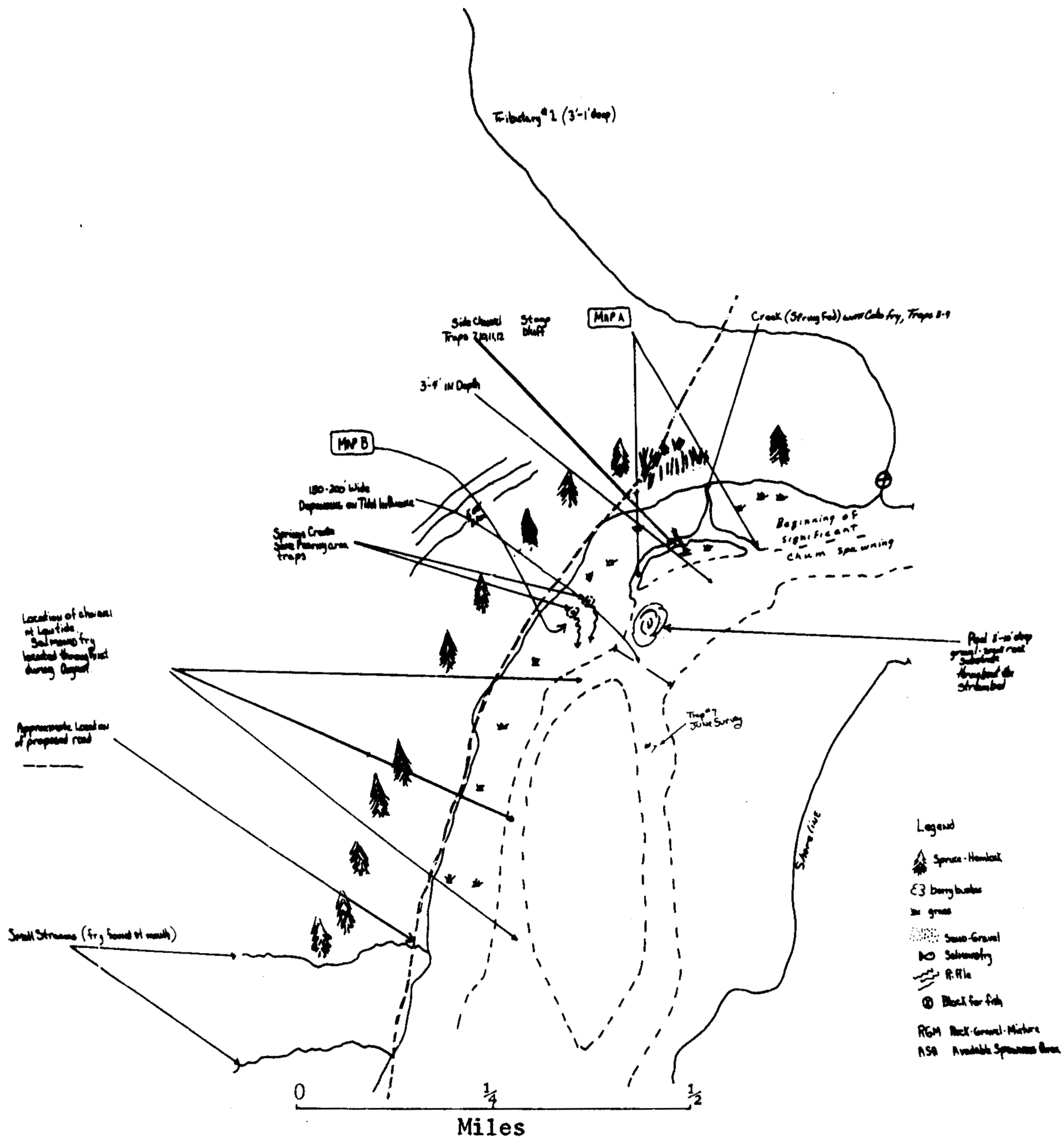


Figure 2. Intertidal area of Keta River (includes legend for all figures).

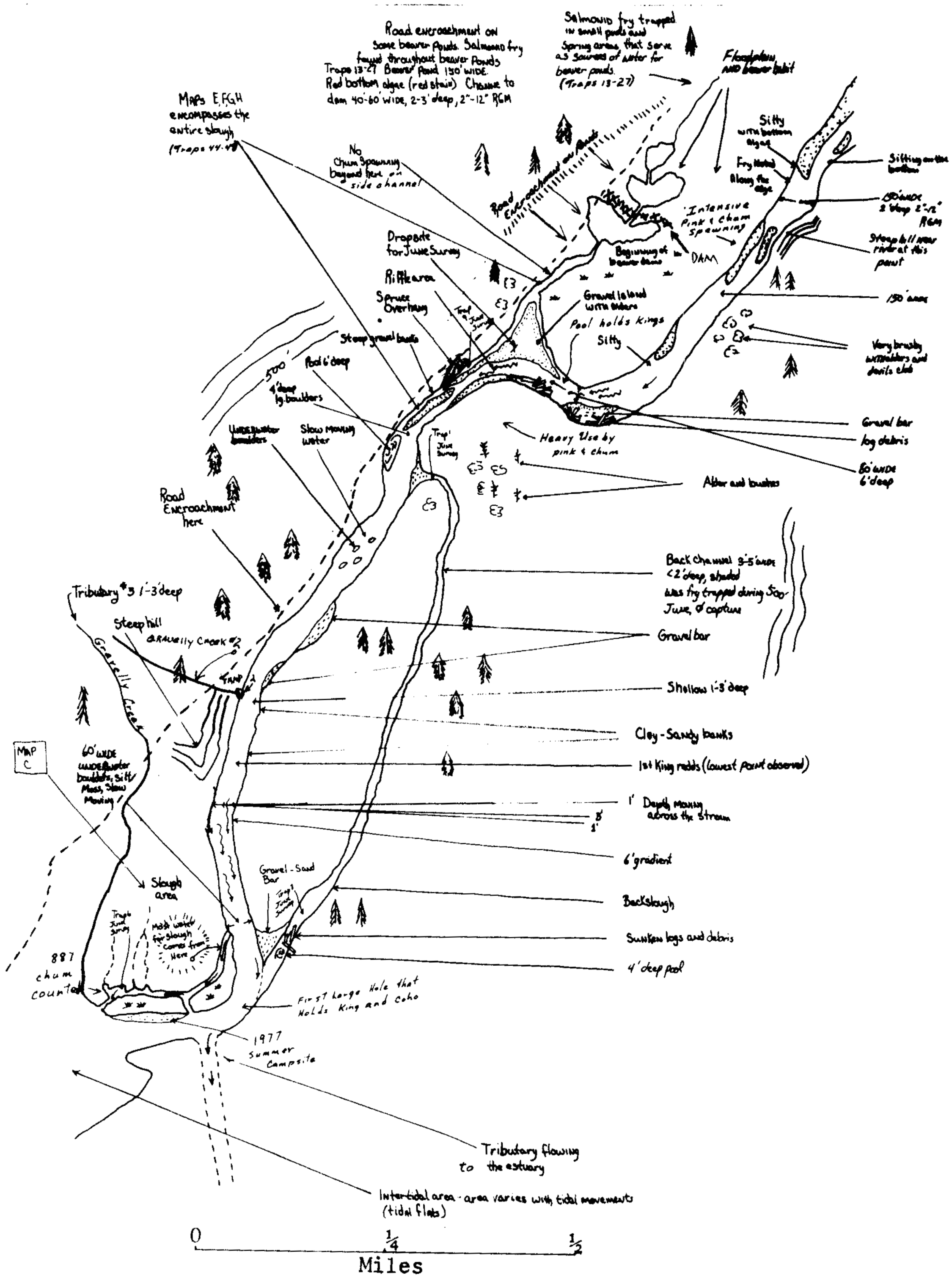


Figure 3. Keta River from upper intertidal to about 1.6 mile (2.6 kilometers) showing Gravelly Creek, slough area, and lower beaver ponds and associated areas of potential road encroachment.

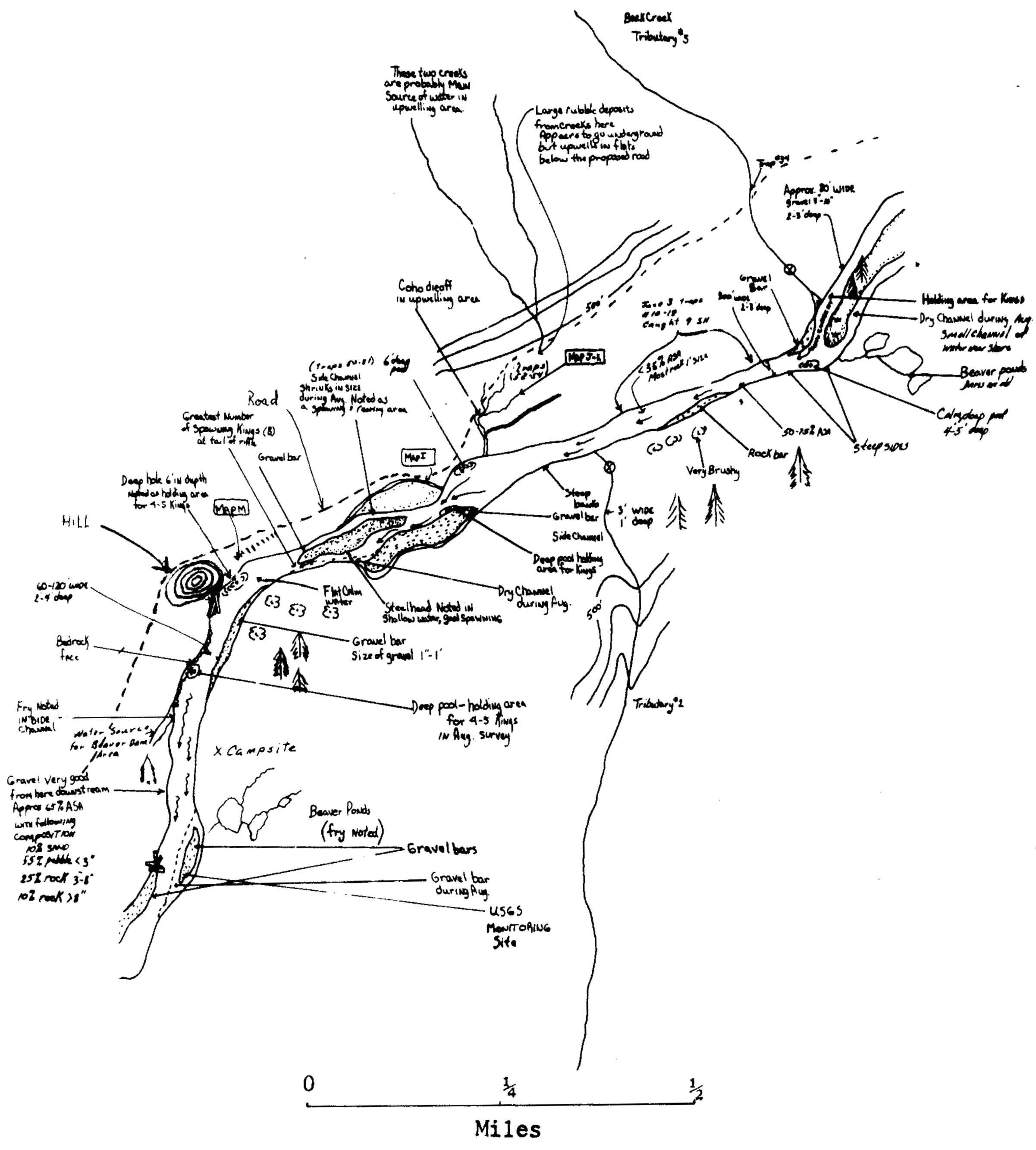


Figure 4. Keta River from about 1.6 to 3.0 miles (2.6-4.8 kilometers) showing beaver ponds, chinook salmon holding and spawning areas, upwelling areas, and steelhead rearing sites below Back Creek.

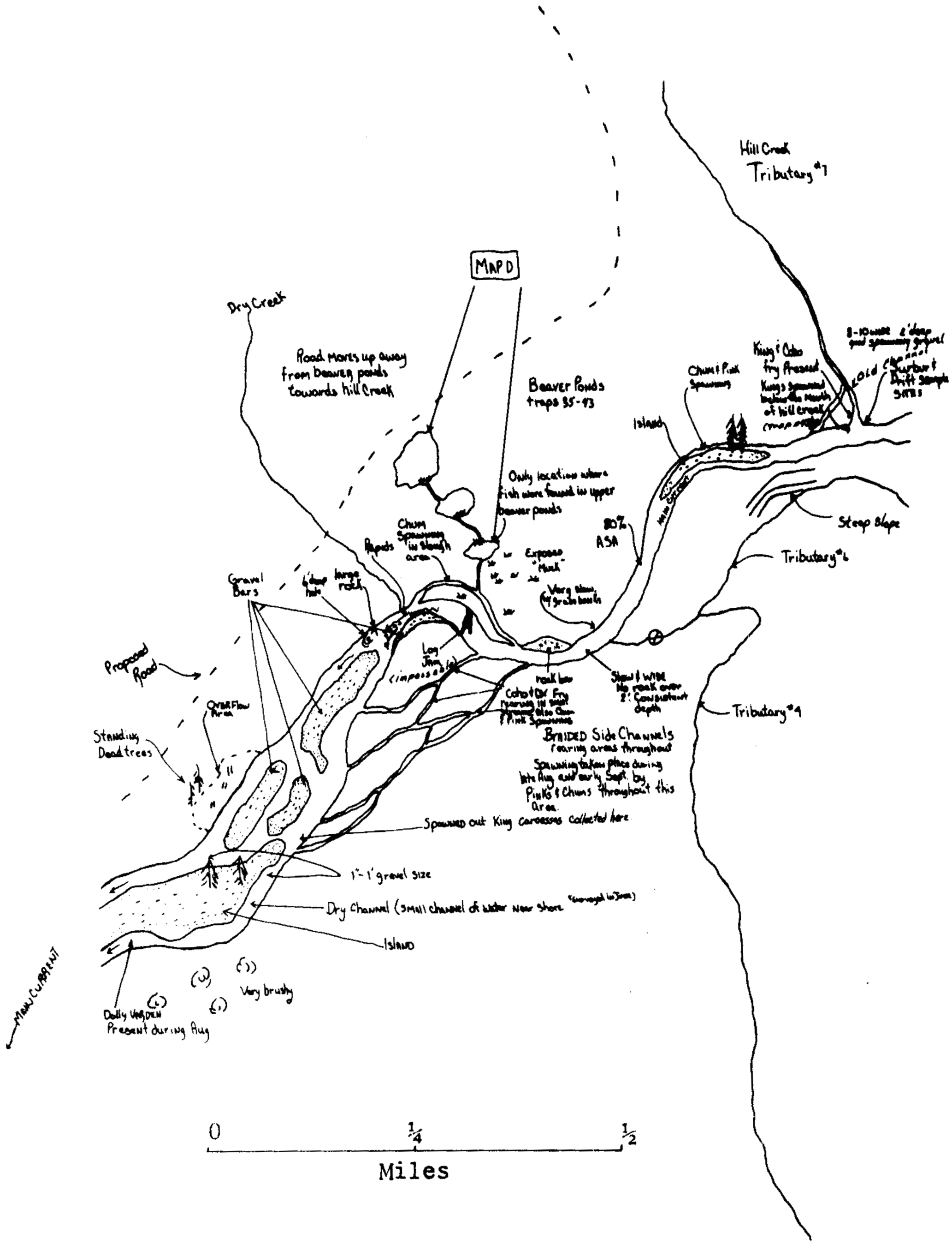


Figure 5. Keta River from about 3.0 to 4.1 mile (4.8-6.6 kilometers) showing upper beaver pond area and spawning and rearing areas below Hill Creek.

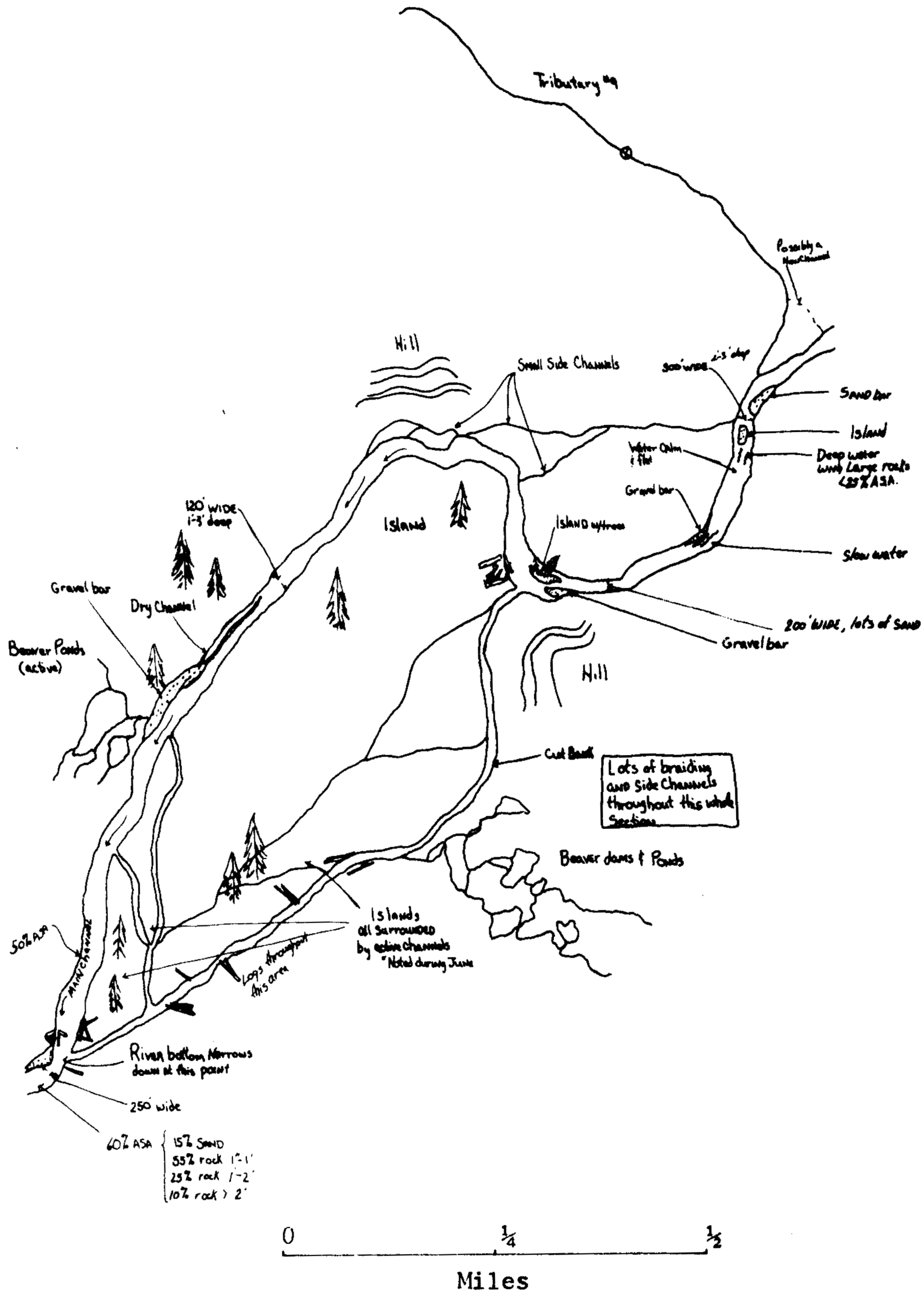


Figure 6. Keta River from about 4.1 to 5.3 mile (6.6-8.5 kilometers).

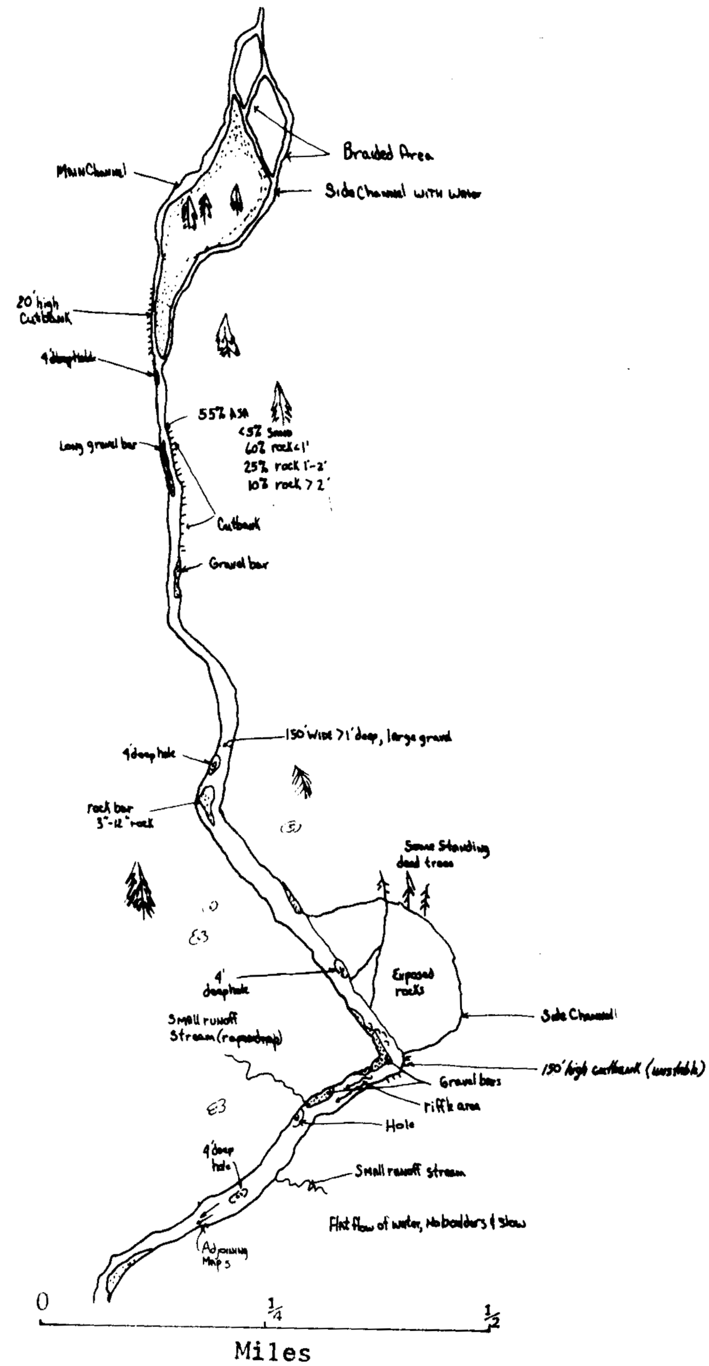


Figure 7. Keta River from about 5.3 to 6.7 mile (8.5-10.8 kilometers).

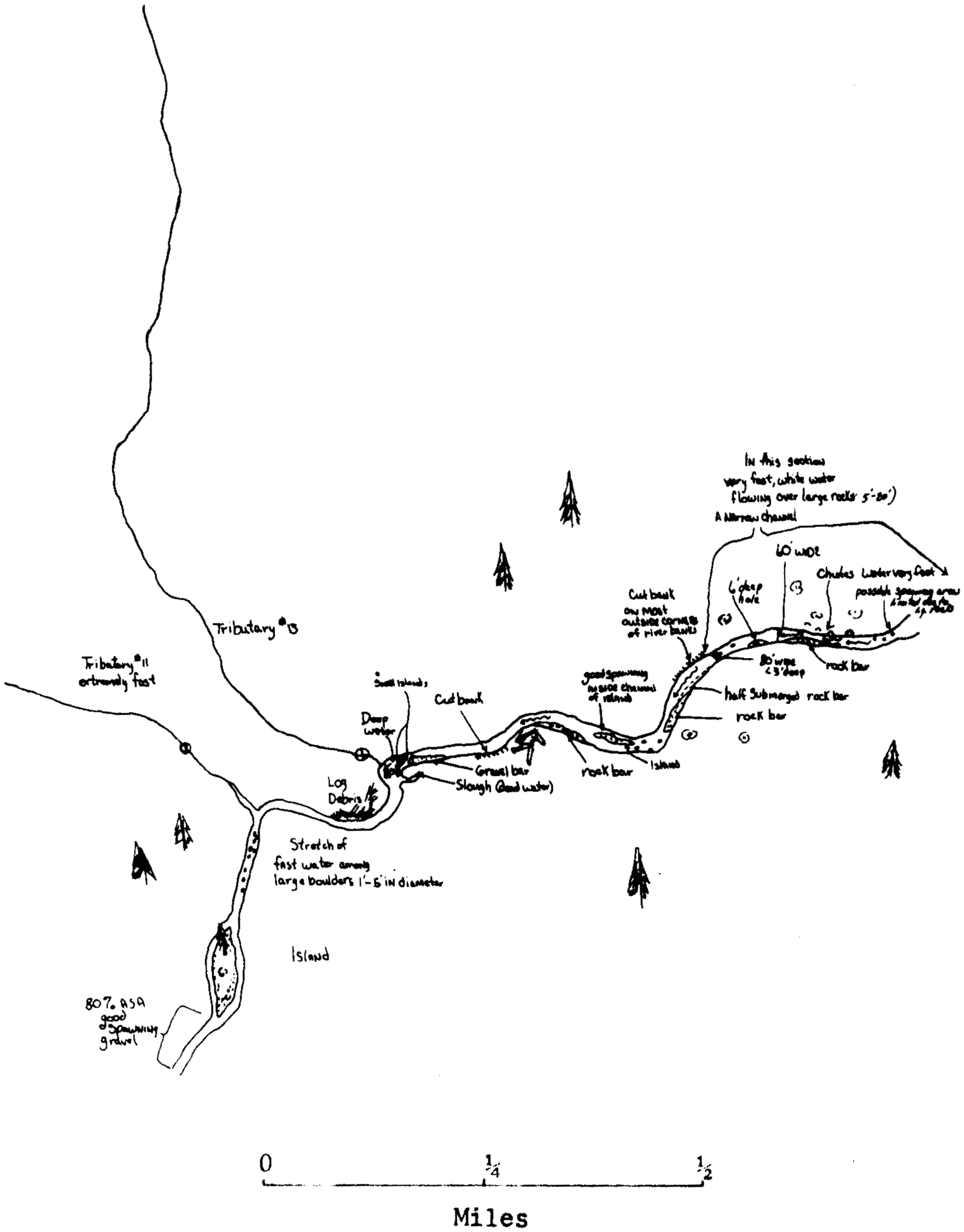


Figure 8. Keta River about 6.7 mile (10.8 kilometers).

important for spawning and rearing, and possible location of the road right of way for the U.S. Borax, Quartz Hill, molybdenum mining prospect. Figures 9 through 11 are the insert maps (A-M) referenced by Figures 2 through 8. These insert maps show important areas in enlarged detail.

Fry Trapping Results and Rearing Areas

Intertidal Zone:

Fry traps 1 through 12 of the July 18 through August 19 survey (Table 1) were set in the intertidal zone on the northwest banks of the Keta River (Figures 1 and 9-A and B) to determine distribution of fish in this area. The traps were located in small sloughs, side channels, or where small springs drained into the Keta River. Salmonid fry were observed in the small sloughs, side channels, and spring areas but were only captured in one area. About 100 salmonid fry were observed in the small channel draining a grassy area that will be crossed by the proposed road (Figure 9-A). Fry were observed in the side channels and where the spring waters flowed into the Keta River at low tide.

Beaver Ponds:

Traps 13 through 33 set in the first set of beaver ponds (Figure 3) showed coho salmon, O. kisutch (Walbaum), and Dolly Varden, S. malma (Walbaum), throughout the system with the exception of one small pond. The upper ponds were dry except for narrow channels winding throughout the lower ponds. Coho salmon fry were present in the channels where the proposed road crosses the beaver ponds (Figure 3).

The other set of beaver ponds are located between Dry Creek and Hill Creek along the proposed road (Figures 5 and 9-D). Of the minnow traps (Traps 35-39), only two contained coho salmon fry. Movement from the one pond (Trap 39) appeared to be restricted by recent beaver dam constructions both up- and downstream. Removal of these barriers would allow for distribution of fish throughout the system. Encroachment into the beaver pond area will occur in the lower reach of the ponds (Figure 9-D).

A single trap (No. 34) was placed in Back Creek (Figure 4), resulting in Dolly Varden being captured. The fish were readily observed in the shallow side pools.

Slough Areas:

The Lower Slough (Figure 3 and 10 E-H) and the Upper Slough areas (Figures 4 and 11-I) adjacent to the proposed road were trapped (Traps 44-51). These areas were previous main river channels and are sustained through seepage from the main Keta River and spring sources. The sloughs contained rearing chinook, O. tshawytscha (Walbaum), and coho salmon and Dolly Varden.

Fill from the road will cover or encroach into these sloughs in several locations. Loss of spawning and rearing habitat will occur even if the road location is moved as close to the base of the slope as possible.

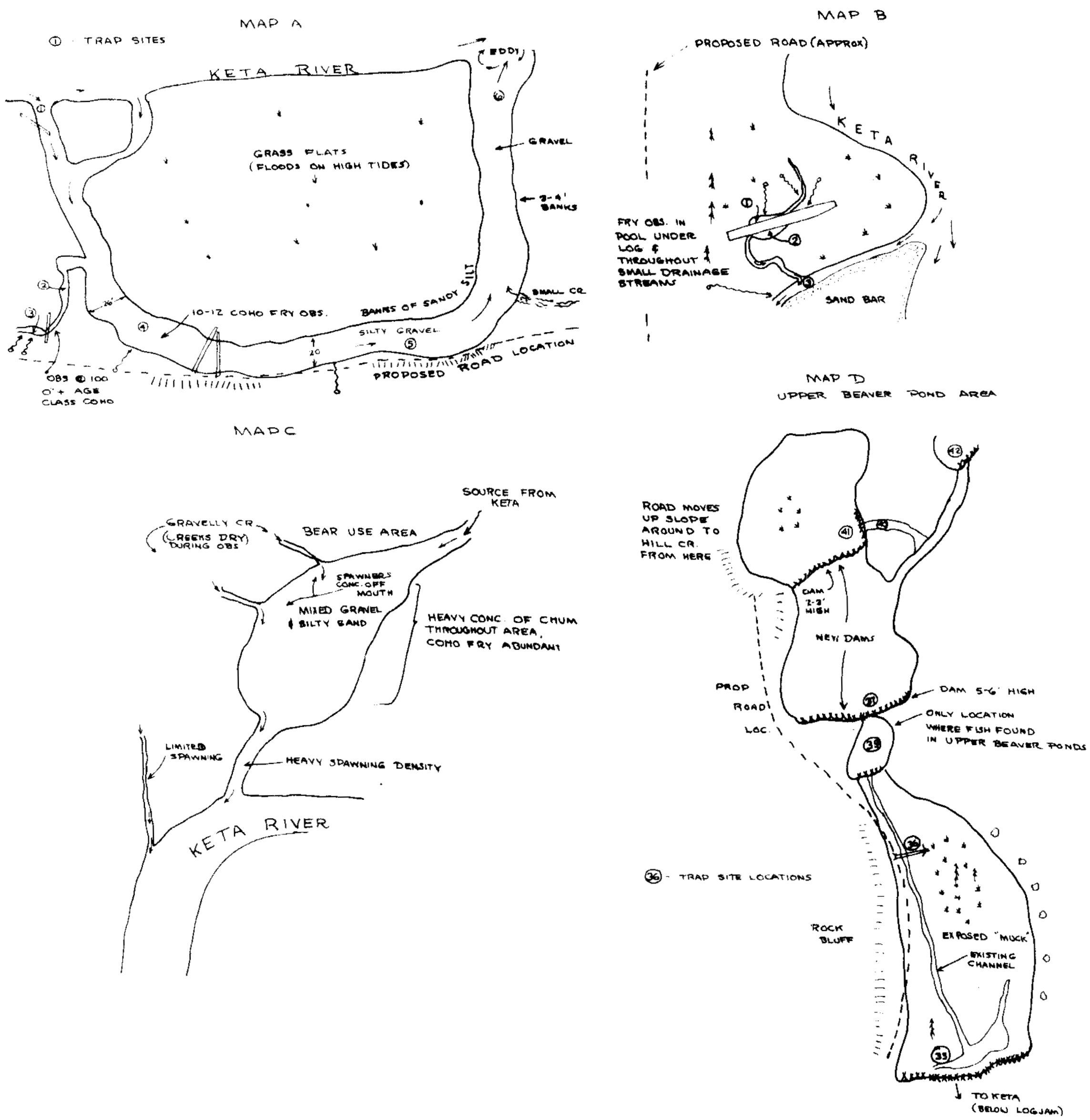
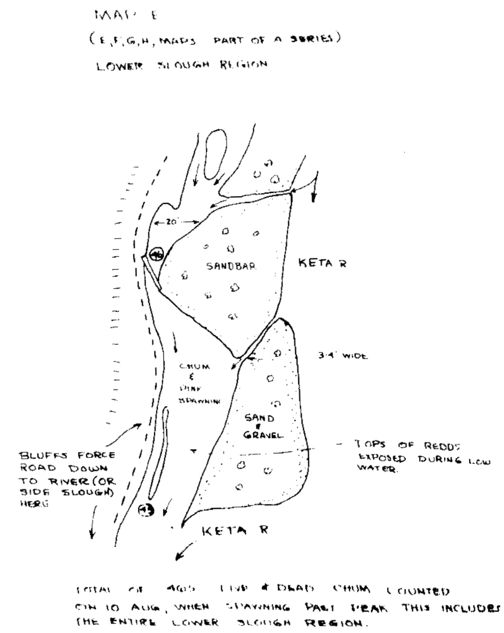
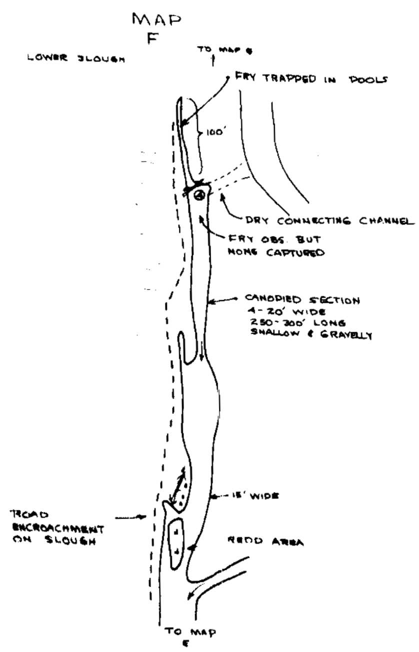
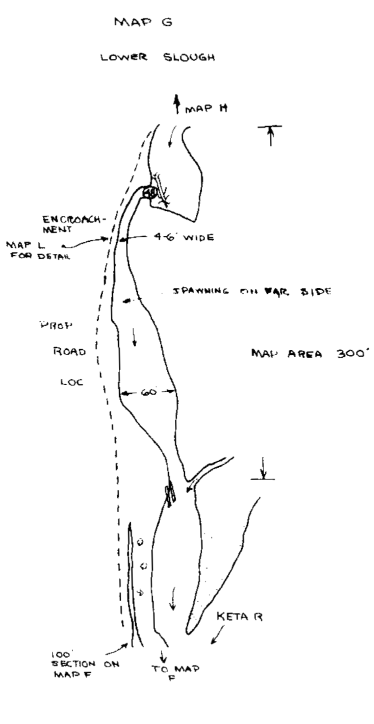


Figure 9. Map inserts A-D.







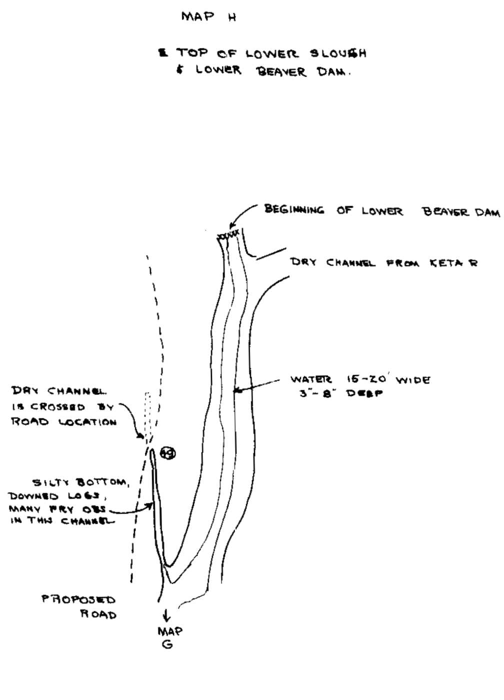


Figure 10. Map inserts E-H. Lower Slough area.

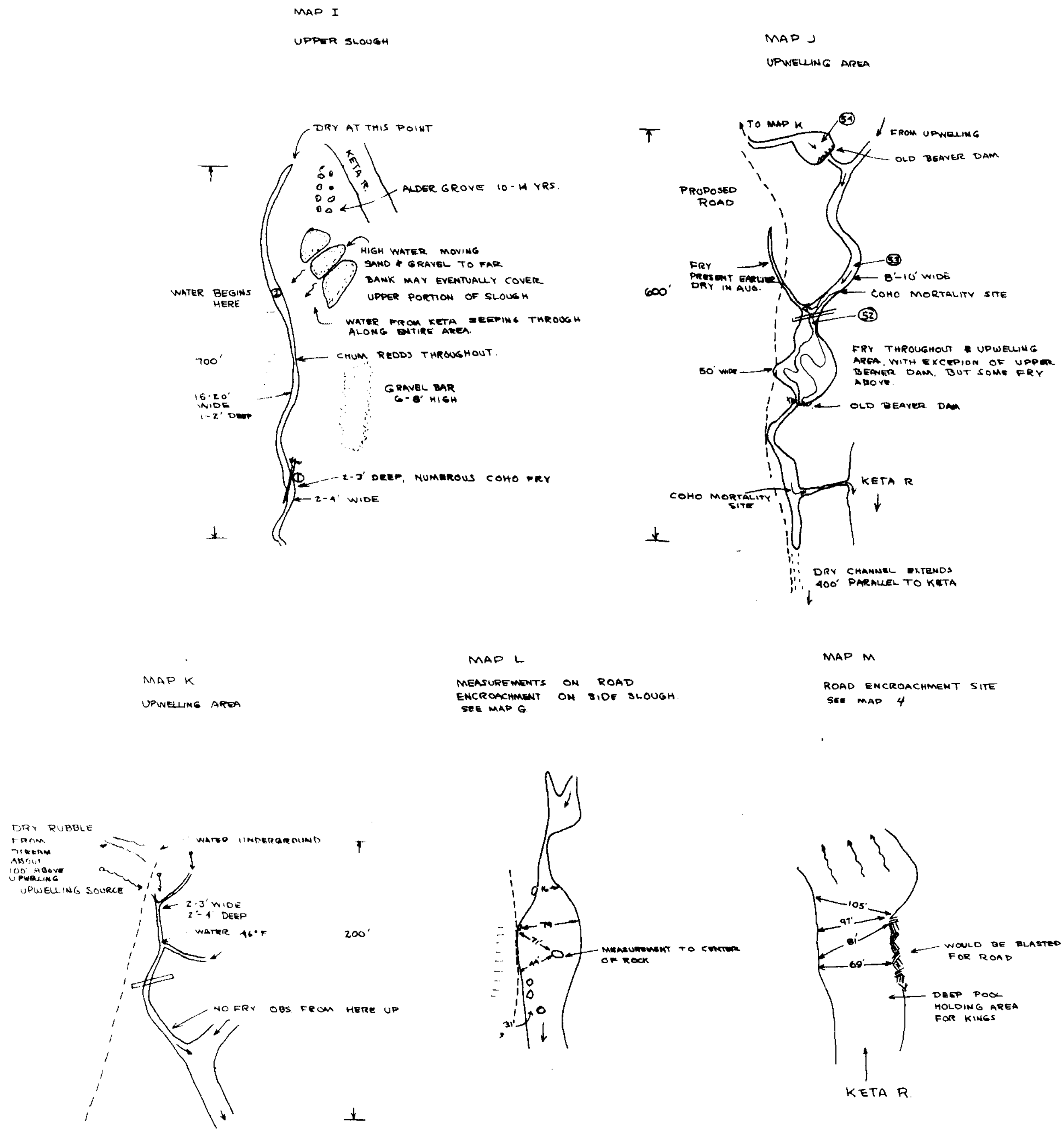


Figure 11. Map inserts I-M.

Table 1. Fry Trap Results, Keta River, 1977.

Trap No.	Time In	Time Out	SS	KS	DV	RT	Comments
			June 2				
A	0930	1010					
B	1015	1045					
C	1330	1430					
D	1435	1535					
E	1545	1745					
F	1550	1740	15		35		
G	1605	1735					
H	1615	1730					
I	1630	1700	2				
			June 3				
1	0920	1325					
2	0930	1330	1		8		
3	0945	1345	2		1		
4	1000	1350			1		
5	1005	1400					
6	1020	1415					
7	1035	1430					
8	1045	1450					
9	1220	1305					
10	1015	1236	29			4	
11	1030	1331	2				
12	1047	1338					
13	1104	1350	13			4	
14	1116	1401				1	
15	1137	1356	2				
16	1141	1404	1				
17	1406	1512					
18	1432	1515					
			July 18 - August 19				
1	1110	1420					
2	1115	1420					
3	1130	1420					Fish observed near trap.
4	1200	1305					
5	1200	1305					
6	1205	1305					
7	-	-	1				
8	-	-	24				
9	-	-	31				
10	-	-					
11	-	-					
12	-	-					
13	1040	1345	65				

Table 1. (Cont.) Fry Trap Results, Keta River, 1977.

Trap No.	Time In	Time Out	SS	KS	DV	RT	Comments
14	1050	1356	6				
15	1100	1400	7		2		
16	1130	1256	6				
17	1140	1254	12				
18	1150	1246	25				
19	1305	1530	2				
20	1310	1531					
21	1315	1533	22		8		
22	1550	1655	30		6		
23	1600	1700					
24	1610	1708	4				
25	1620	1715	10		1		
26	1625	1725	11				
27	1630	1720					
28	1545	1820					
29	1606	1706	28	5			
30	1615	1718	6				
31	1623	1730		1			
32	1626	1754	17	2			
33	1630	1810	30	1			
34	1031	1955		9			
35	1210	1442	1				Coho 110 mm.
36	1222	1448					
37	1235	1452					
38	1245	1500					
39	1255	1454	11				
40	1550	1855		2			
41	1552	1854					
42	1600	1848					
43	1450	1740	6	2	3		
44	1130	1500	40	2	1		
45	1130	1450	23				
46	1140	1405	34	29	5		
47	1210	1330					Pulled and reset in same
	1330	1610					location.
48	1240	1643	17				
49	1249	1646	1				
50	1052	1155	4				
51	1110	1225	5	3			
52	1330	1515	16	1			
53	1355	1500	20	1			
54	1400	1505	11	1			

Upwelling Area:

Particular attention was given an upwelling area about 0.4 kilometer (0.25 mile) below Back Creek (Figure 4 and 11-J-K). This area provides a buffered temperature throughout the winter and is important as rearing habitat for coho and chinook salmon and other salmonids during winter months. Fry were noted in this area during a November survey. One portion of the upwelling area that contained water and salmonid fry in the spring was dry during August. Whether this dry condition is normal or due to the unusually dry weather is not known. The proposed road location crosses the upwelling source area and then parallels the stream for about 91.4 meters (300 feet). Salmonid fry were observed throughout the area (Traps 52-54) with the exception of the upper sections of the stream. An inactive beaver dam is believed to be acting as a partial barrier. To fully assess the importance of this area, a winter survey is advised. The constant temperature provided by the upwelling may provide valuable overwintering habitat.

Steelhead Rearing Area:

On June 3 a series of nine fry traps were set about 0.4 kilometer (0.25 mile) below Back Creek (Figure 4), capturing nine rearing rainbow trout, *S. gairdneri* Richardson.

Adult Escapements and Spawning Areas

Chinook Salmon:

Chinook salmon were first noted on July 23, and surveys were initiated on July 26. (Table 2). Chinook salmon were counted from a riverboat by two or sometimes three observers. Counts were made from the intertidal zone to about 4.8 kilometers (3 miles) upstream where Back Creek flows into the Keta River. The chinook salmon remained in deeper pools until August 2 when ten were observed in shallow riffles. On August 19 all chinook salmon observed were over redds. One spawned-out female was observed on August 19. A peak aerial count on August 17 yielded 230, of which 108 were below the mouth of Hill Creek. The proposed road will infringe on the river in one area that serves as a holding pool for upstream migrants and fish waiting to spawn.

Coho Salmon:

No peak count of adult coho salmon was made during 1977 because of equipment problems. During a partial float trip (3.4 kilometers) on September 11 approximately 200-250 coho salmon were observed. All fish were schooled in deep riffle and pool areas. Many were observed schooled in the deep pool along the rock outcropping where the proposed road will encroach on the lower river area. Coho salmon were the most abundant fry captured during the summer.

Chum Salmon:

A unique area for chum salmon, *O. keta* (Walbaum), was located at the outfall of Gravelly Creek. A count of 887 spawners was made in this

Table 2. Chinook salmon surveys from mouth of Keta River to Back Creek, 1977.

Date of Survey	Number of Chinook	Remarks
July 22	3	Boat survey.
26	20	Boat survey.
28	25	Boat survey.
29	39	Boat survey.
August 2	36	Boat survey. Wind ripple on water hampered observation on up river survey.
2	59	Boat survey. Ten fish in shallow portion of pools.
9	61	Boat survey. Eighteen fish in shallows or on redds.
17	230	Helicopter - total stream survey. 108 fish below Hill Creek.
19	59	Boat survey. One spawned-out female; all fish over redds.

area just after peak spawning on August 1. This count did not include fish taken by bear or carcasses that floated away. The bear utilization in this area was heavy. Most of the fish were in the large pool area with greatest spawning activity near the outlets of Gravelly Creek. As a significant portion of the water for this area comes from the Keta River proper near the moraine deposit, care should be taken to preserve this source in the event the moraine area is selected as the townsite.

The lower and upper slough areas are also very important for chum salmon spawning. A total of 465 spawners was counted in the lower slough area after the peak spawning on August 11.

Aerial surveys by Commercial Fisheries Division estimated 14,500 fish, mostly chum salmon, on July 26 and 34,000 fish, mostly pink salmon, O. gorbuscha (Walbaum), on August 3, 1977.

Pink Salmon:

Pink salmon were observed throughout the Keta River to Hill Creek. No reliable ground counts were made during this survey. Commercial Fisheries Division estimated 34,000 fish, mostly pink salmon, on August 4, 1977.

Steelhead Trout:

One adult steelhead trout, S. gairdneri Richardson, was caught during a foot survey, April 24, 1975. One adult steelhead trout was seen on June 3, 1977, during an aerial survey. It appears that the steelhead trout population in the Keta River is not large with probably less than 100 fish returning annually. Discussions with commercial fishermen Ron Porter and Pat Kristovich indicate the Keta River has been an important steelhead fishery in late December (pers. comm. between Don Siedelman, Sport Fish biologist, and fishermen Ron Porter and Pat Kristovich, February 2, 1978).

Cutthroat Trout:

No cutthroat trout, S. clarki Richardson, entered during the surveys or fry trapping.

Dolly Varden:

Dolly Varden use the system, as evidenced by fry trapping and angling. The number of fish which enter the system in the fall is not known, as no fall surveys were conducted.

Potential Loss of Habitat From Road Encroachment

Information regarding the road location was gathered this summer. The final location of the road has not been staked; so, as of now, no calculations of habitat loss are possible.

Preliminary road location information indicates that physical displacement of fish habitat due to road placement will be minimized where possible. The road will traverse some very difficult terrain, and construction practices will be exacting. Fifteen bridges and over 90 culverts will be placed during the first season's construction period. Steep hillsides immediately above fish spawning, rearing, and holding areas will be blasted or excavated to place a full bench road.

While little physical displacement of fish habitat is planned, the potential for habitat impairment and degradation due to siltation and road failure is high. This is particularly true near the upwelling areas of the side channels and the subsurface flow areas feeding the beaver ponds.

Very little construction experience exists for building roads that affect chinook salmon habitat on mainland rivers in southeast Alaska. Chinook salmon, because of their small populations, spawning and rearing requirements, and the high fishing pressure exerted on the stocks, would probably be affected most by road construction. Forty-seven percent of the 1977 chinook salmon escapement spawned below Hill Creek.

Coho salmon may be the second most affected species. Coho salmon utilize both the side channels and beaver ponds for rearing purposes. Habitat in these areas will be permanently lost due to road fills.

Chum salmon could be the third most affected species because of their affinity for spawning in the upwelling areas of the side channels. Road construction in these areas will have an effect on the upwelling areas through loss of habitat due to road fill and the possible interruption of groundwater flows.

Pink salmon, which spawn in the side channels to a lesser degree than chum salmon, may be the least impacted species as a result of road construction. Commercial Fisheries Division estimates that 80% of the pink and chum salmon spawn below Hill Creek.

SECTION III

OBJECTIVE

To evaluate the fishery potential of lakes which are being considered for hydroelectric projects.

BACKGROUND

Growth and development in southeast Alaska towns has resulted in increased demand for electrical energy. One potential source of this energy is from hydroelectric generation. Hydroelectric sites would ideally be located near the demand source to eliminate transmission problems. Water power for the hydroelectric turbines would come from lakes with dammed outlets.

Damming natural lakes results in modification of existing fauna and flora through alteration and/or extinction of habitat. Changes in fish populations and numbers are a natural result of these changes.

Four lakes chosen as probable hydroelectric sites include Virginia Lake near Wrangell and Grace, Mahoney, and Swan lakes near Ketchikan. The purpose of this study was to evaluate the habitat and fish populations existing in these lakes.

RECOMMENDATIONS

1. It is recommended that Virginia Lake not be used as a hydroelectric site if a suitable alternative is available in the Wrangell-Petersburg area.

2. If Virginia Lake is to be developed, a plan for mitigation should be developed.

3. Development of Swan Lake in the Ketchikan area would have a lesser effect on fishery potential than Mahoney or Grace lakes.

TECHNIQUES USED

Limnological investigations were conducted on four lakes to determine fishery and recreational potential. Lakes and dates of study are: Grace, June 13 through 17; Mahoney, June 17 through 30 and August 1; Swan, August 30 through September 2; and Virginia, July 18 through 22.

Bathymetric maps were prepared for each of the lakes. A recording fathometer was used to record depth contours on transects crossing each lake. The depth contours were transferred to bathymetric maps, and morphometric data were calculated from these maps.

Sampling stations were established at approximately the deepest portion of each lake. Vertical profiles of temperature and specific conductance were recorded at each station. Field chemical analyses, including alkalinity titrations, were conducted according to Standard Methods (1971).

Zooplankton were collected biweekly by making duplicate vertical tows from the lake bottom with each of two nets. Nets used were 0.5 m diameter and 3 m long. Straining cloth of the No. 10 Nitex net had aperture of 153 microns and 45% open area, while the No. 20 Nitex net had aperture of 80 microns and 35% open area. Plankton were identified and counted. Efficiency of nets was not accounted for in calculations. Thermal profiles and Secchi disc readings were taken in conjunction with plankton tows.

Stream drift organisms were collected by placing two nets in the main inlet. Nets used were 12 inches square, 3 feet long, made with Nitex with pore size of 280 microns, and 45% open area. Benthos were preserved and later identified and enumerated in the laboratory.

Bottom fauna were collected by dredging with an Ekman 6-inch dredge. Bottom samples were washed through three screens, the finest having 28 meshes per inch. Organisms were preserved in 70% ethyl alcohol or frozen until laboratory analysis.

Age, growth, and food habits of fish in the lakes were determined from fish collected throughout the study period.

FINDINGS

Morphometry

The depth, size, and shape of lakes strongly influence physical and chemical conditions which prevail in them. Since physical and chemical parameters limit species composition and abundance of organisms, it is essential to study the morphometric features of lakes. Bathymetric maps of Grace Lake (Figure 12), Mahoney Lake (Figure 13), Swan Lake (Figure 14), and Virginia Lake (Figure 15) were prepared from sounding data. Morphometric data for these lakes are presented in Tables 3 through 6. Mean depths of the lakes is as follows: Grace, 61.5 m; Mahoney, 39.2m; Swan, 86.8 m; and Virginia, 13.1 m.

The main inlets and outlets of these lakes were surveyed and sketches prepared showing stream bottom type, pools, obstructions, and general configuration. The main inlet to Grace Lake is shown in Figure 16. The outlet and inlets to Mahoney Lake are shown in Figures 17 and 18. The main inlet and minor inlets to Swan Lake are shown in Figures 19 and 20. Porterfield Creek (Figure 21) and Glacier Creek (Figure 22) are the main inlets to Virginia Lake. Mill Creek (Figure 23) is the outlet of Virginia Lake.

Physical and Chemical Considerations

Observations of temperature, Secchi disc visibility, pH, conductivity, and alkalinity were made on each lake during the survey period. Thermal profiles of Grace, Mahoney, and Swan lakes are shown in Figure 24. All lakes were holomictic, having two circulation periods per year. Pronounced thermal stratification during the summer season varied from 2 m to 10 m, depending upon wind conditions.

Secchi disc visibility was good in Grace (12 m), Mahoney (10 m) and Swan lakes (9.5 m). No Secchi disc readings were taken from Virginia Lake. Alkalinity conductivity and pH of all lakes is summarized in Table 7.

Plankton

Zooplankton were collected only once from Mahoney and Swan lakes (Table 8).

Benthos

Analysis of stream drift organisms from inlets to Grace, Swan, Virginia, and Mahoney lakes are presented in Table 9.

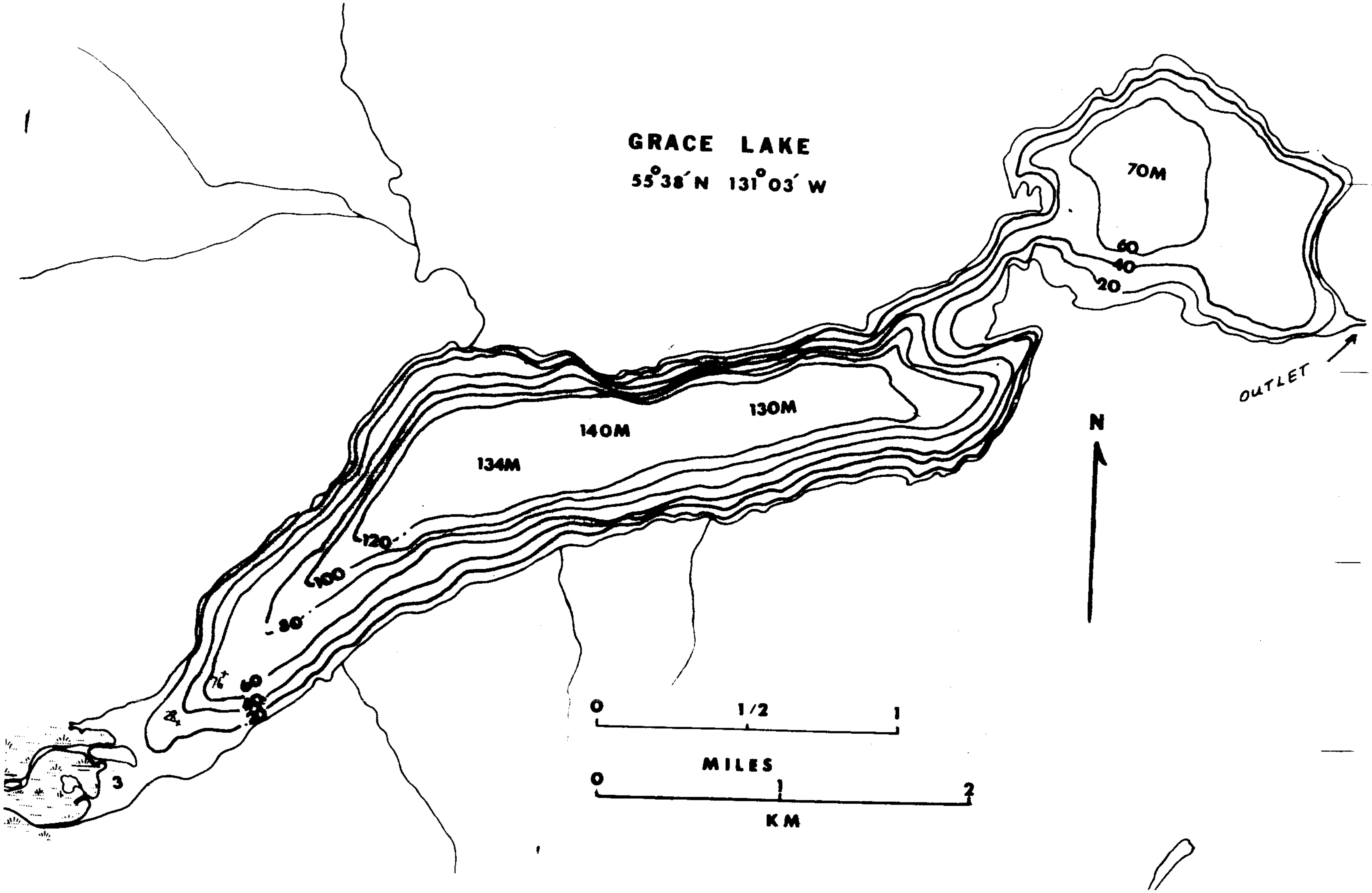


Figure 12. Bathymetric map of Grace Lake.

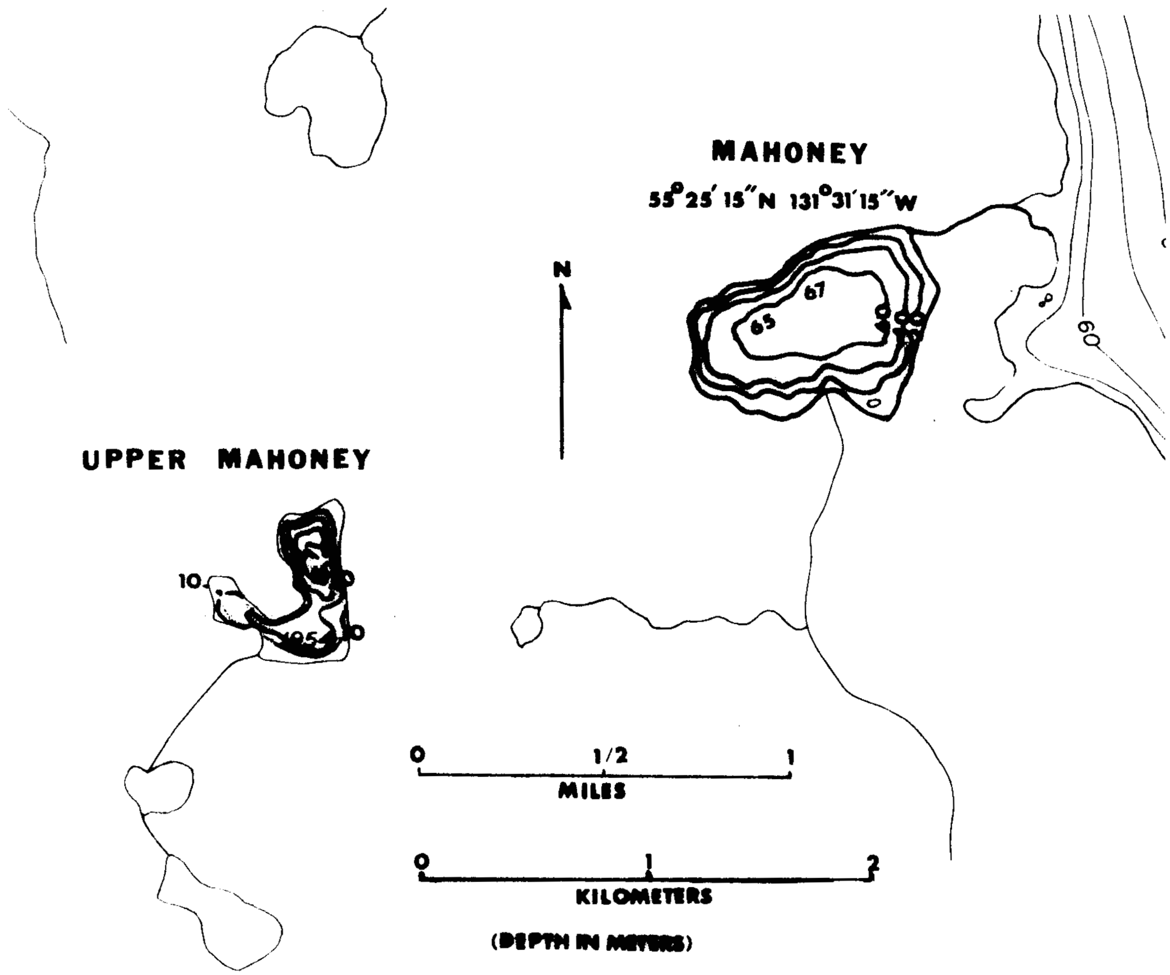


Figure 13. Bathymetric map of Mahoney Lake.

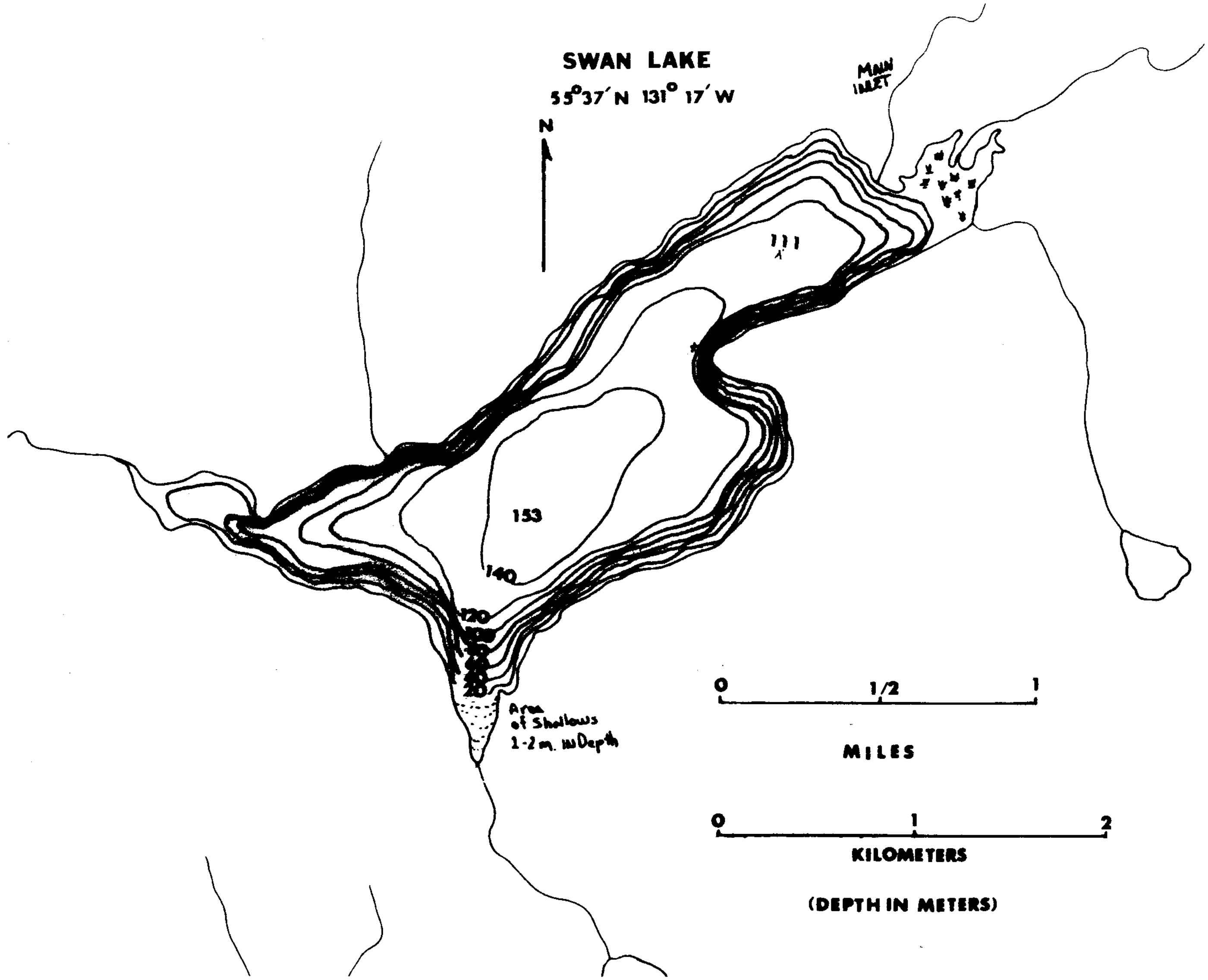


Figure 14. Bathymetric map of Swan Lake.

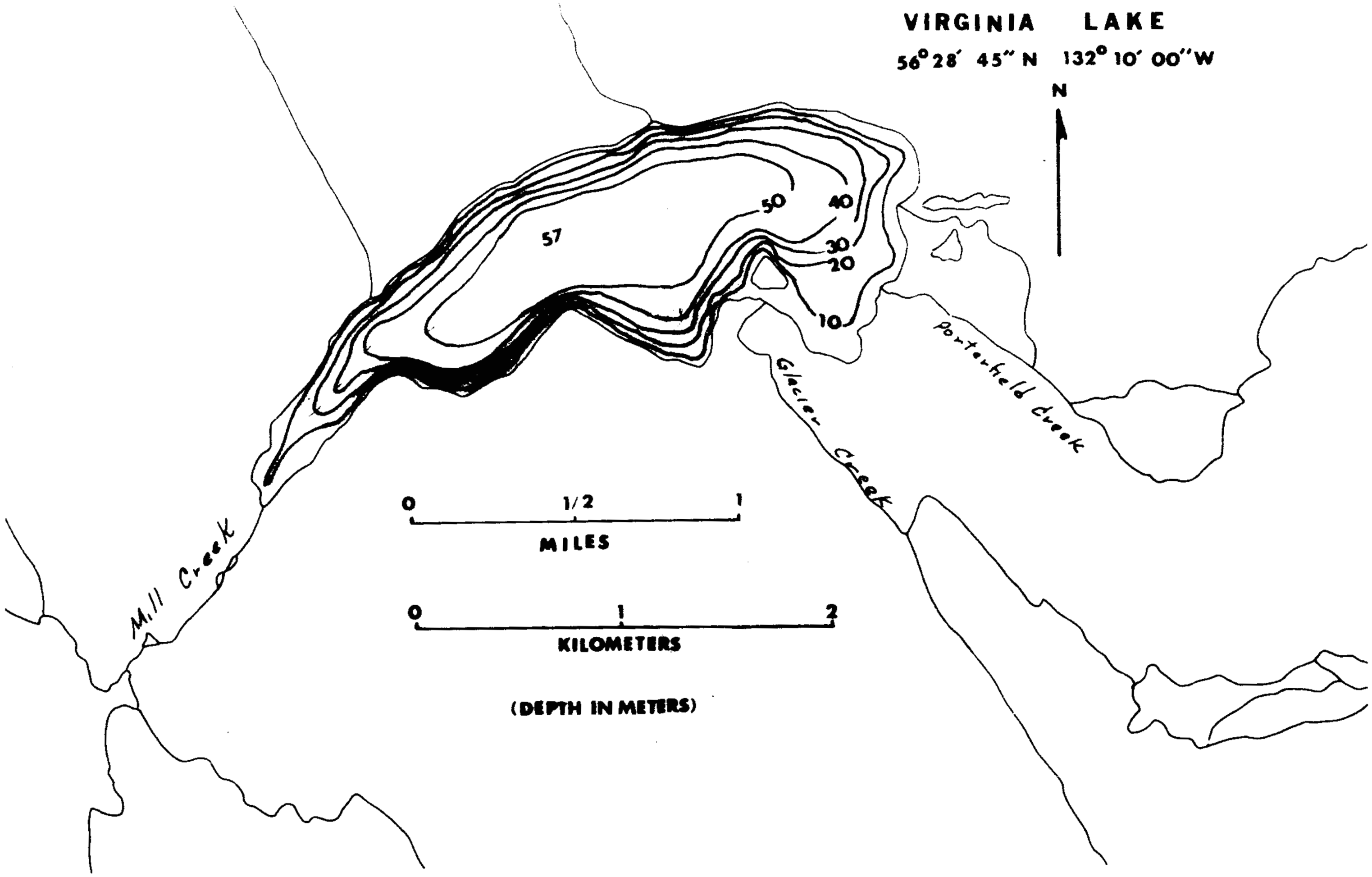


Figure 15. Bathymetric map of Virginia Lake.

Table 3. Morphometry of Grace Lake.

Water Area 660.4 ha or 1,631.2 acres

Area by Depth Zone

Depth Zone (m)	Area (m^2)	Percent of Total Area
0- 20	1,062,686	16.1
20- 40	931,894	14.1
40- 60	1,487,760	22.5
60- 80	1,136,256	17.2
80-100	335,155	5.1
100-120	482,296	7.3
120-140	1,110,506	16.8
140	58,448	0.9

Water Volume

Cubic Meters 406.4×10^6

Acre Feet 329.2×10^3

Volume by Depth Zone

Depth Zone (m)	Volume (m^3)	Percent of Total Volume
0- 20	121,317,917	29.9
20- 40	101,384,498	24.9
40- 60	76,849,274	18.9
60- 80	50,664,147	12.5
80-100	18,161,649	4.5
100-120	28,063,554	6.9
120-140	9,925,237	2.2

Maximum Depth = 140.0 m

Mean Depth = 61.5 m

Shoreline Length = 19,155 m

Shoreline Development = 2.1

Table 4. Morphometry of Mahoney Lake.

Water Area 64.6 ha or 159.5 acres

Area by Depth Zone

Depth Zone (m)	Area (m^2)	Percent of Total Area
0-20	196,188	30.4
20-40	73,571	11.4
40-60	179,839	27.8
60-67	186,379	28.9
67	9,809	1.5

Water Volume

Cubic Meters 253.5×10^5

Acre Feet 20.5×10^3

Volume by Depth Zone

Depth Zone (m)	Volume (m^3)	Percent of Total Volume
0-20	10,894,796	43.0
20-40	8,245,302	32.5
40-60	5,625,503	22.2
60-67	583,022	2.3

Maximum Depth = 67.0 m

Mean Depth = 39.2

Shoreline Length = 3,058.4 m

Shoreline Development = 1.0

Table 5. Morphometry of Swan Lake.

Water Area 404.7 ha or 999.6 acres

Area by Depth Zone

Depth Zone (m)	Area (m^2)	Percent of Total Area
0- 20	588,564	14.5
20- 40	351,504	8.7
40- 60	318,806	7.9
60- 80	343,329	8.5
80-100	392,376	9.7
100-120	703,008	17.4
120-140	833,800	20.6
140-153	489,244	12.1
153	25,750	0.6

Water Volume

Cubic Meters 351.3×10^6

Acre Feet 284.5×10^3

Volume by Depth Zone

Depth Zone (m)	Volume (m^3)	Percent of Total Volume
0- 20	74,964,910	21.3
20- 40	65,609,890	18.7
40- 60	58,909,427	16.8
60- 80	52,279,247	14.9
80-100	44,902,601	12.8
100-120	33,761,078	9.6
120-140	17,981,508	5.1
140-153	2,842,230	0.8

Maximum Depth = 153.0 m

Mean Depth = 86.8 m

Shoreline Length = 13,038.5 m

Shoreline Development = 1.8

Table 6. Morphometry of Virginia Lake.

Island Area 1.6 ha or 4 acres

Water Area 257.5 ha or 636 acres

Area by Depth Zone

Depth Zone (m)	Area (m^2)	Percent of Total Area
0-10	429,150	16.7
10-20	368,421	14.3
20-30	299,595	11.6
30-40	311,741	12.1
40-50	449,393	17.5
50+	716,599	27.8

Water Volume

Cubic Meters 33.9×10^6

Acre Feet 27.4×10^3

Volume by Depth Zone

Depth Zone (m)	Volume (m^3)	Percent of Total Volume
0-10	9,408,717	27.8
10-20	7,817,258	23.1
20-30	6,487,094	19.2
30-40	5,256,710	15.5
40-50	3,674,475	10.8
50+	1,226,354	3.6

Maximum Depth = 57.0 m

Mean Depth = 13.1 m

Shoreline Length = 9,115.0 m

Shoreline Development = 1.6

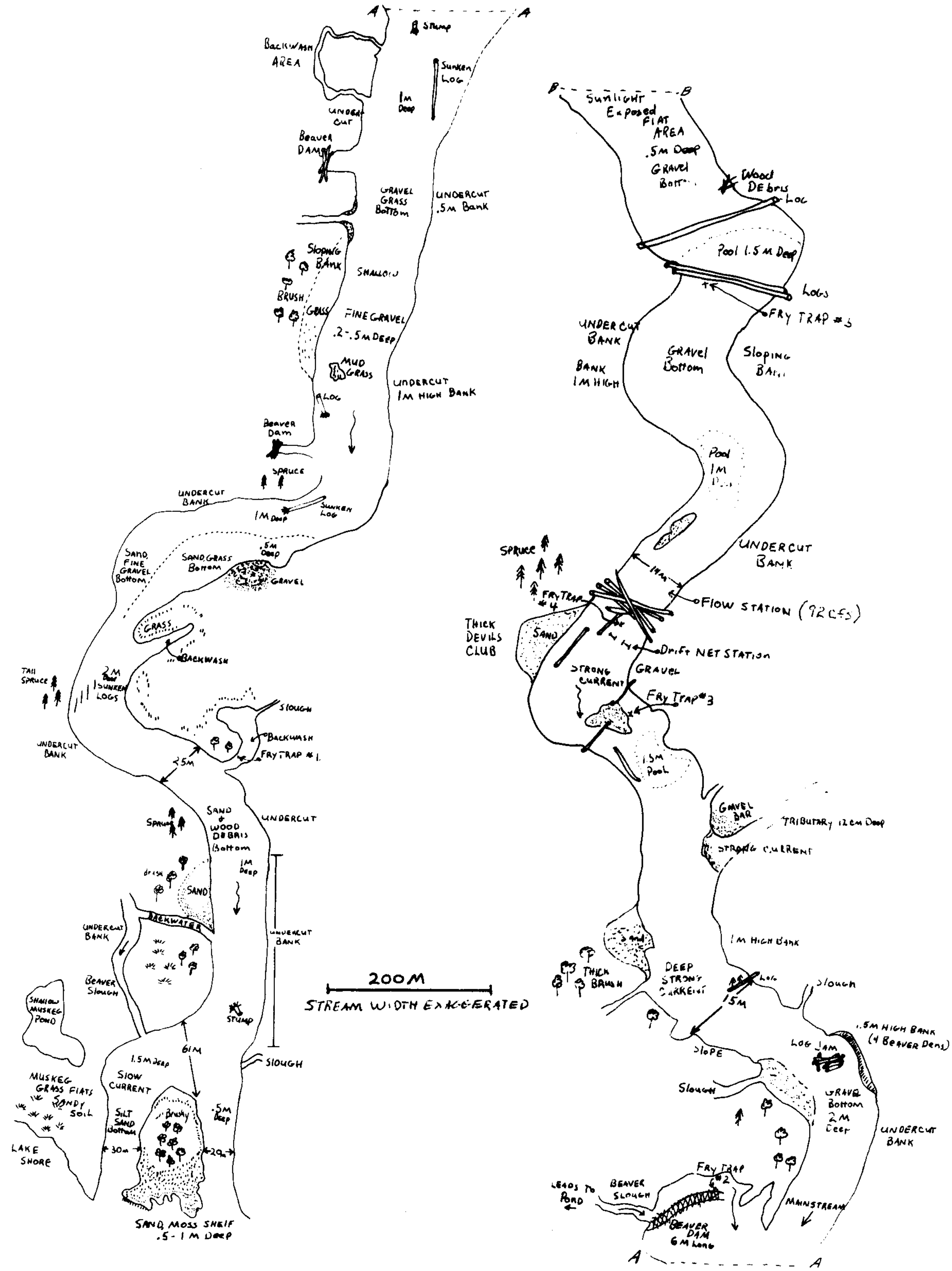


Figure 16. Main inlet to Grace Lake.

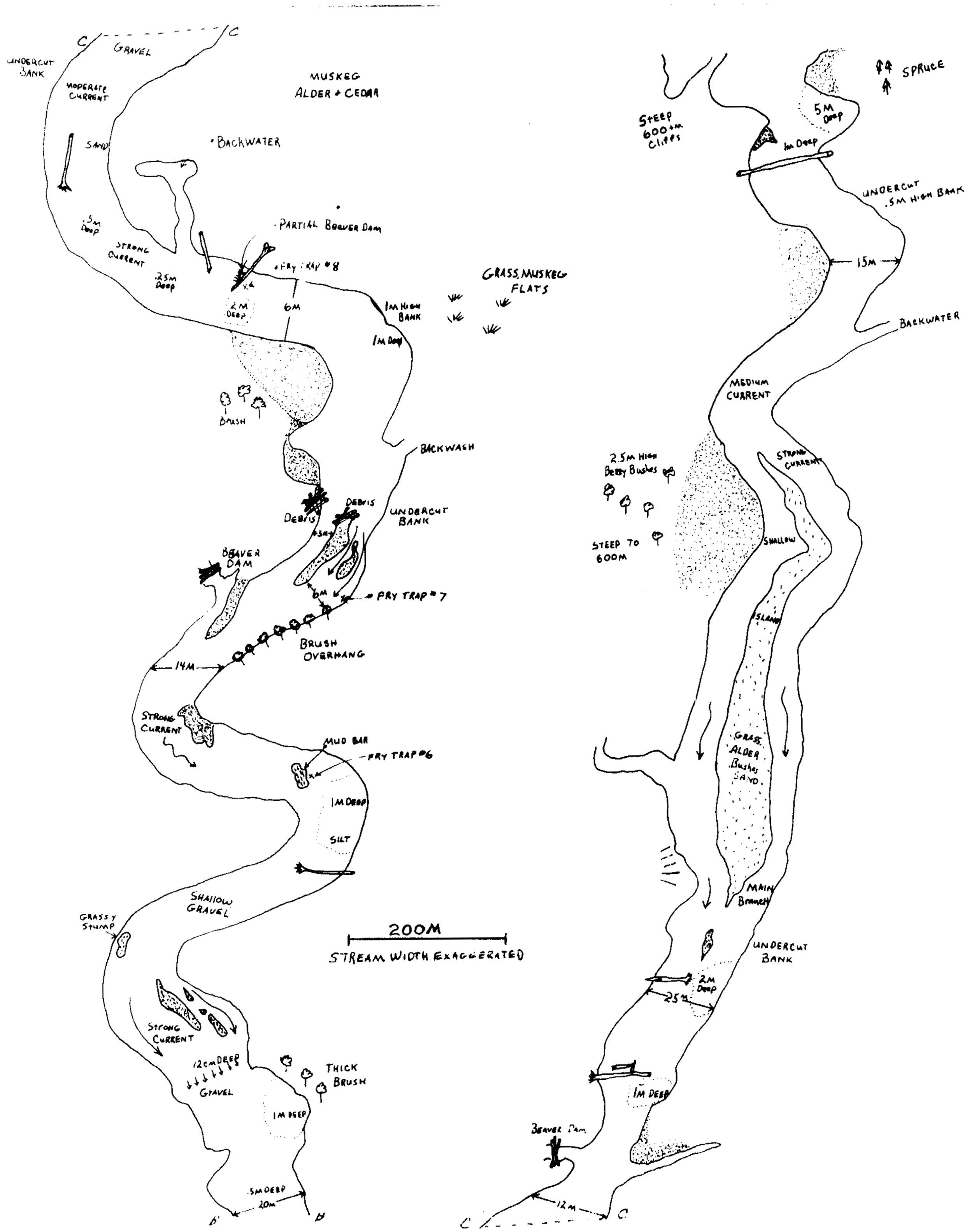


Figure 16. (Cont.) Main inlet to Grace Lake.

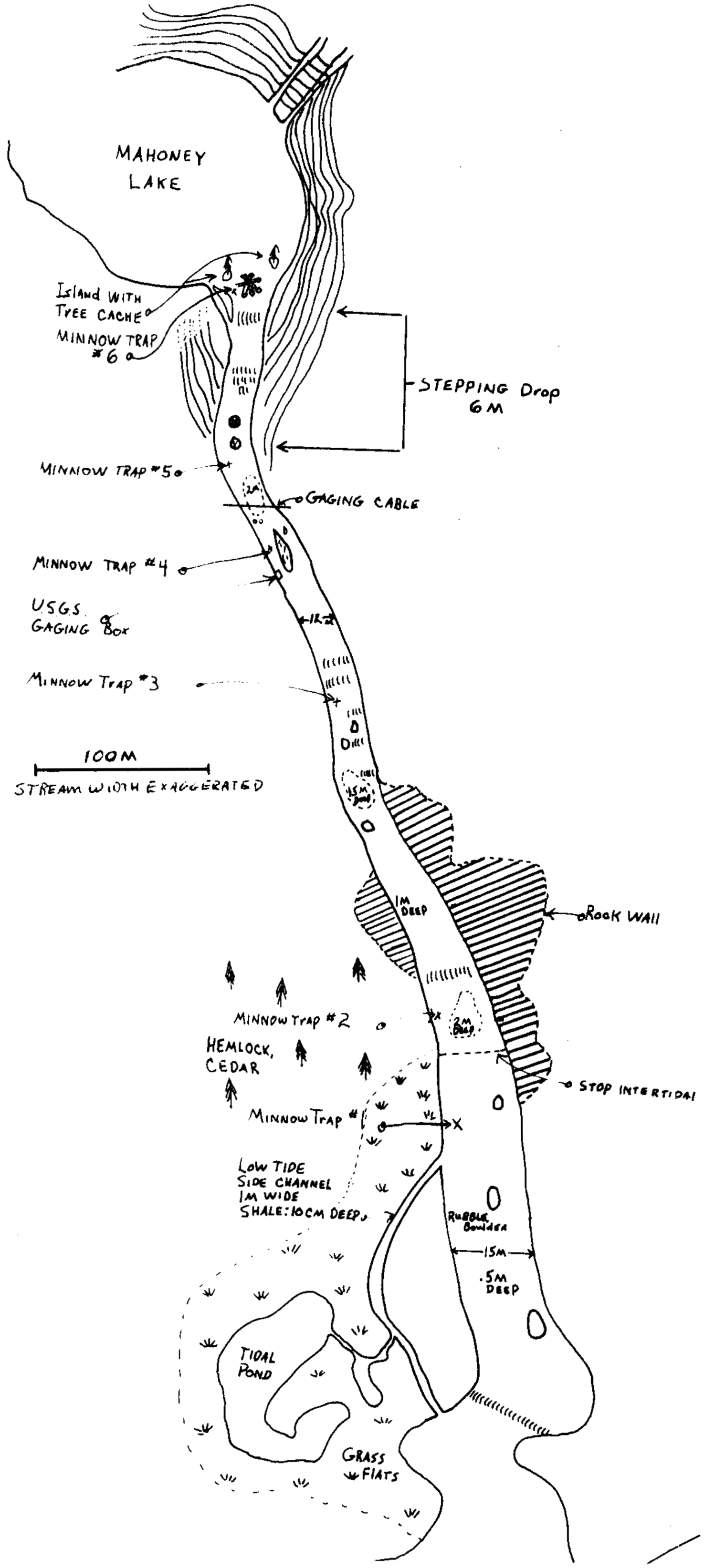
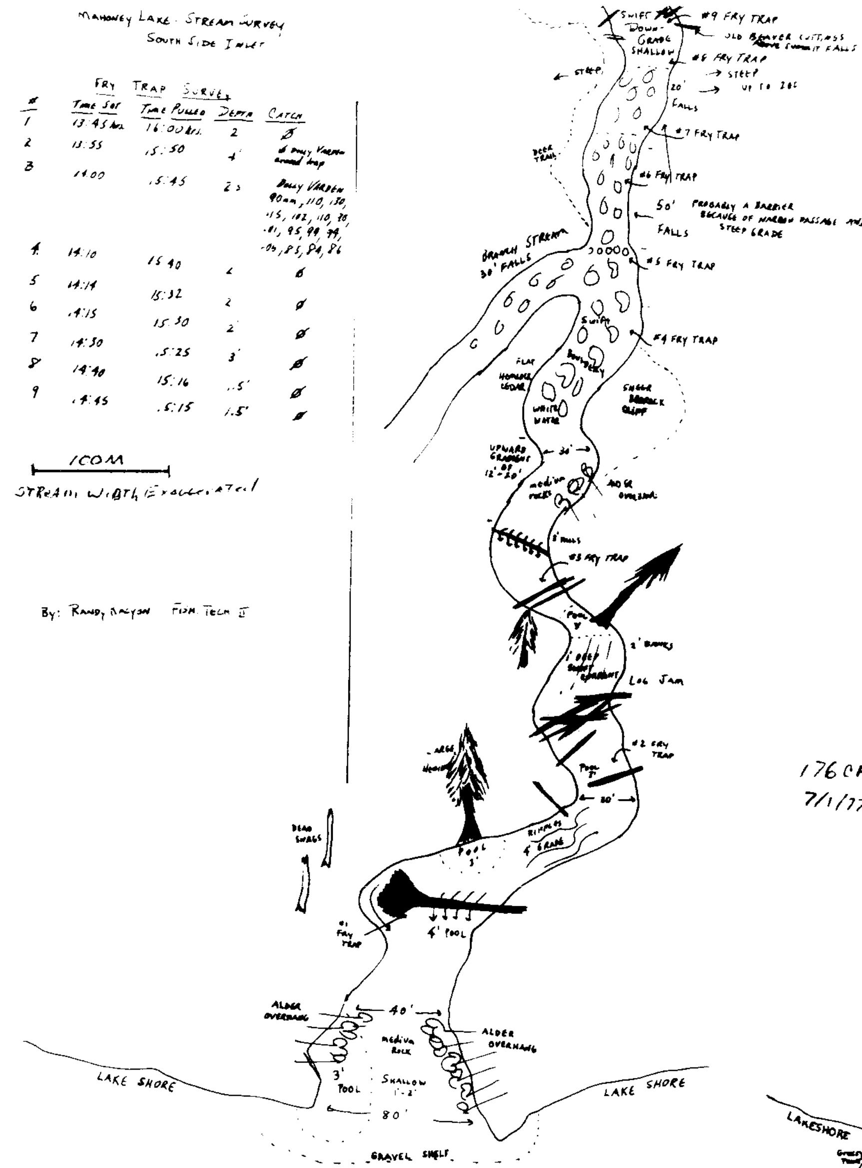


Figure 17. Outlet from Mahoney Lake.



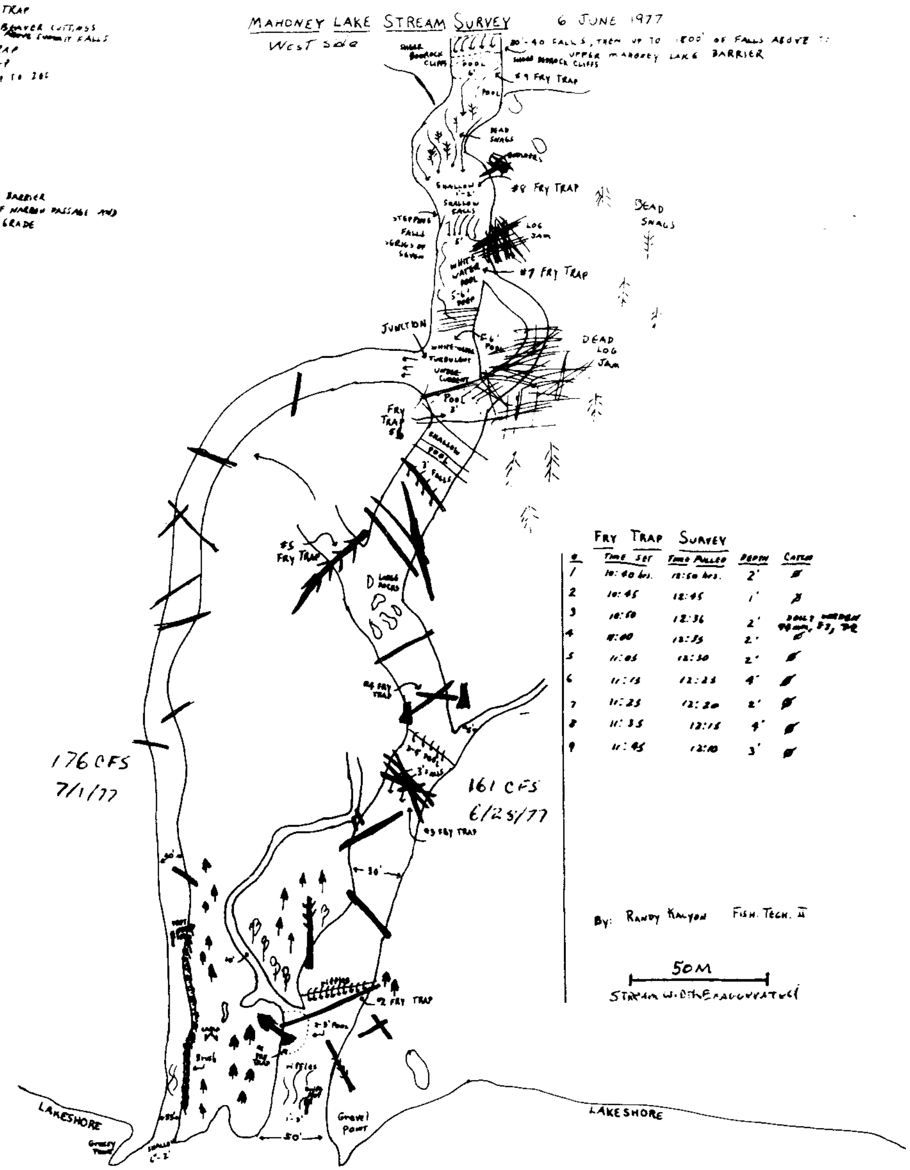


Figure 18. Inlets to Mahoney Lake.

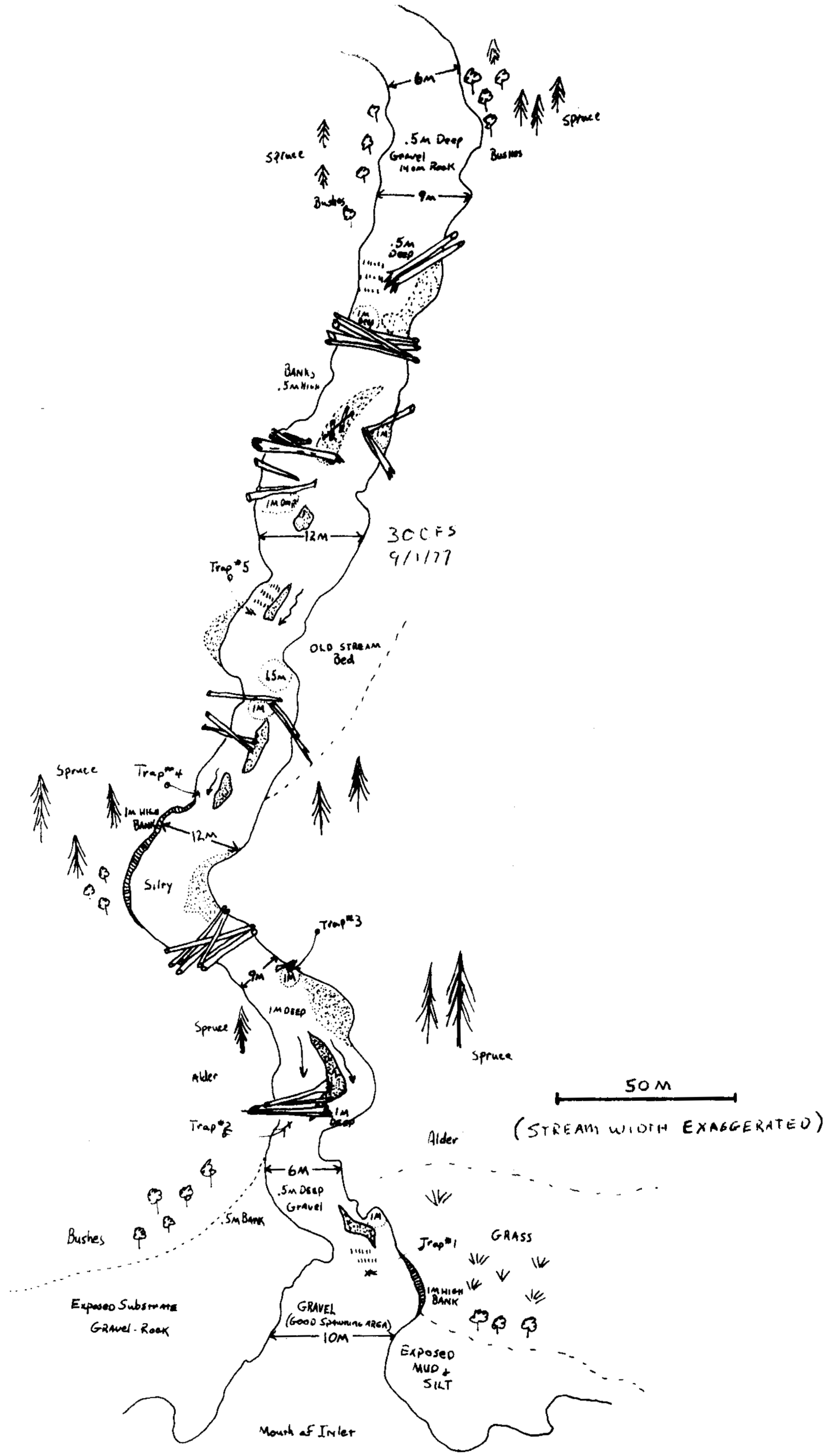


Figure 19. Main inlet to Swan Lake.

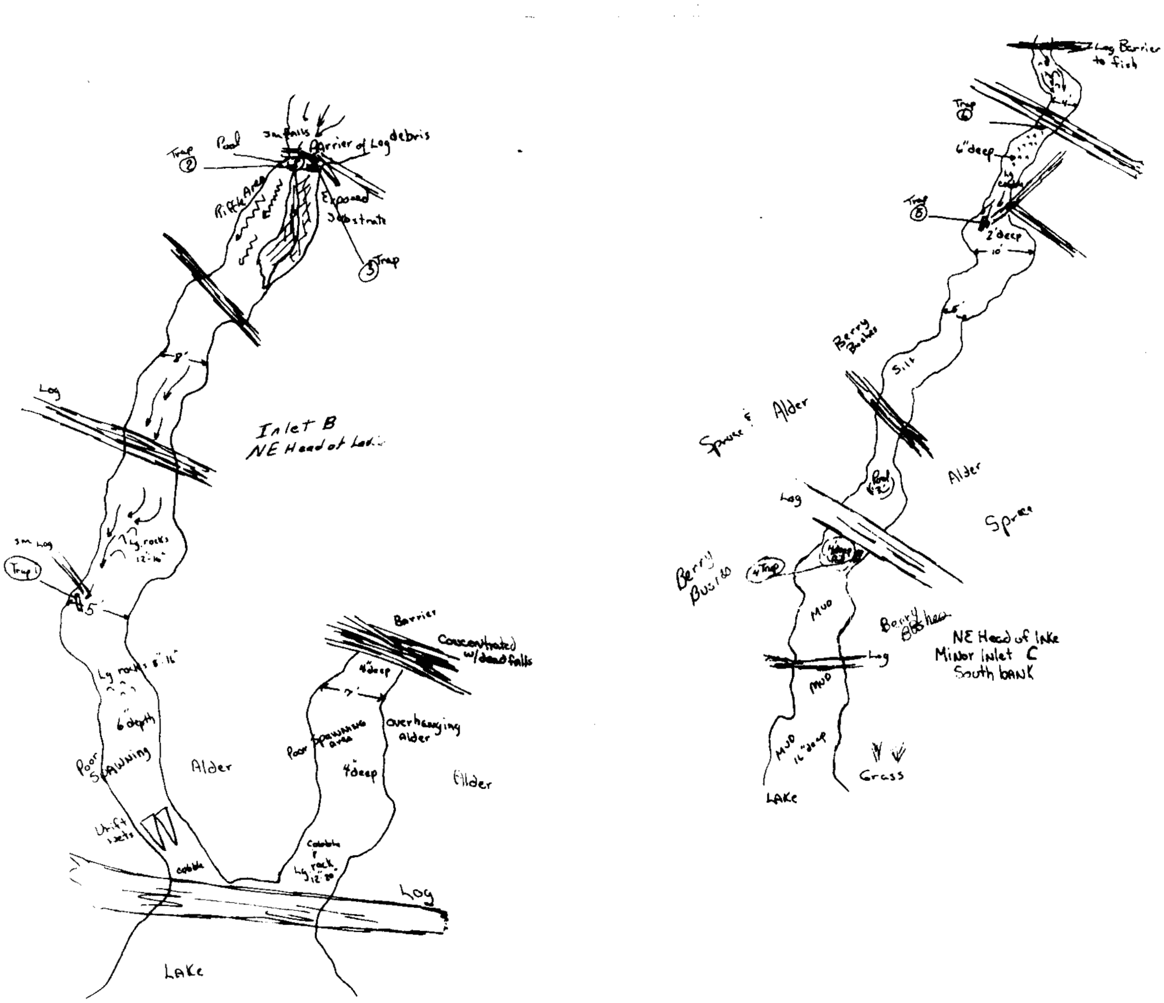


Figure 20. Minor inlets to Swan Lake.

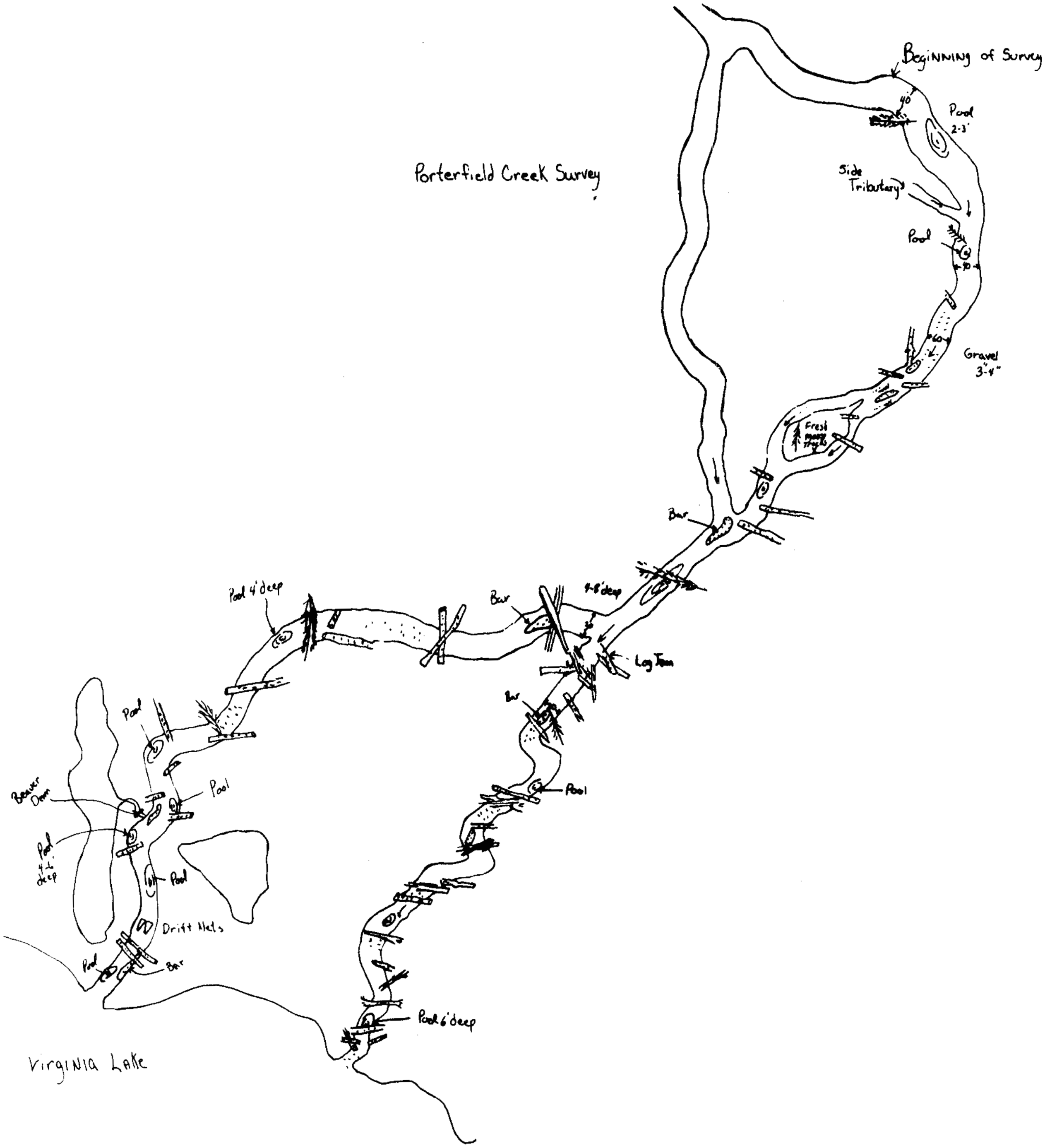


Figure 21. Map of Porterfield Creek.

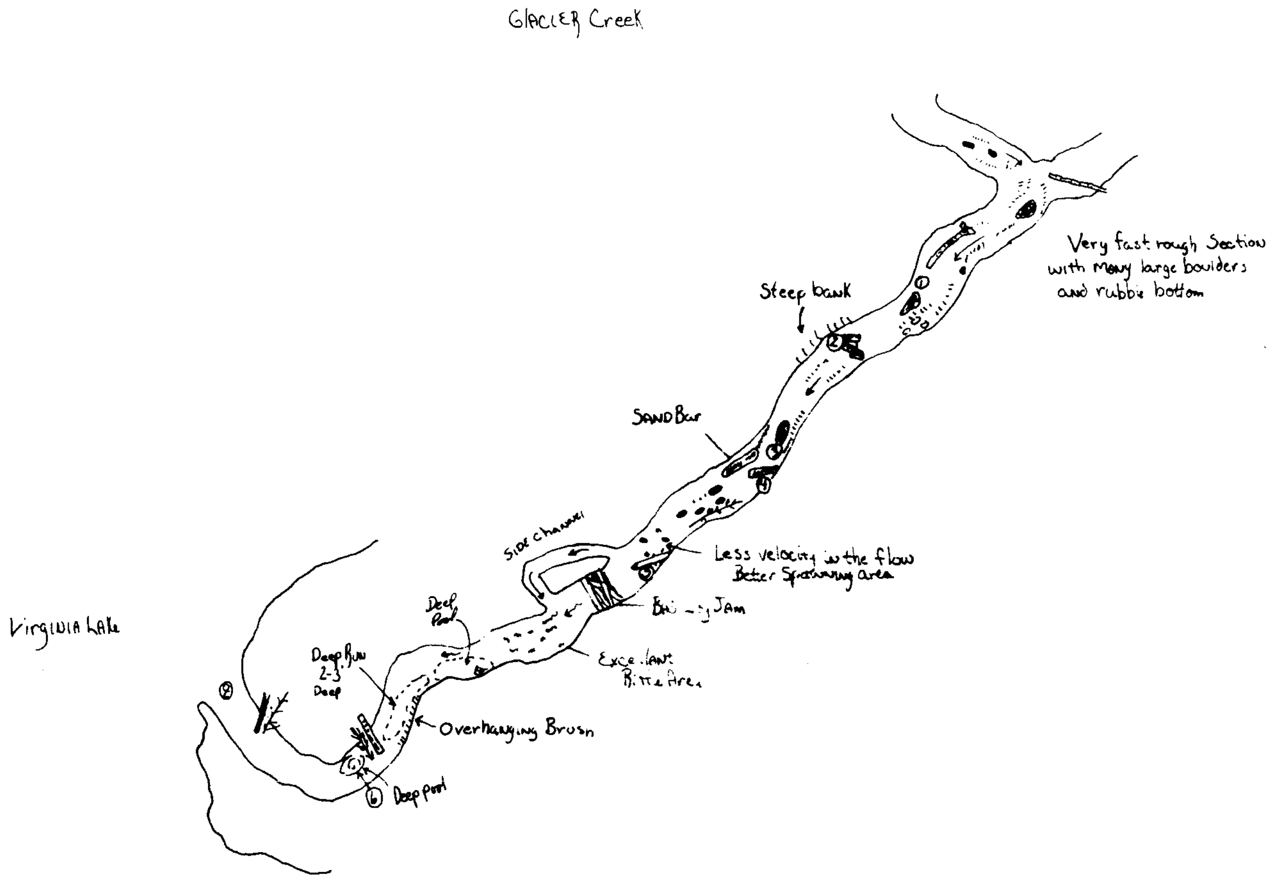


Figure 22. Map of Glacier Creek.

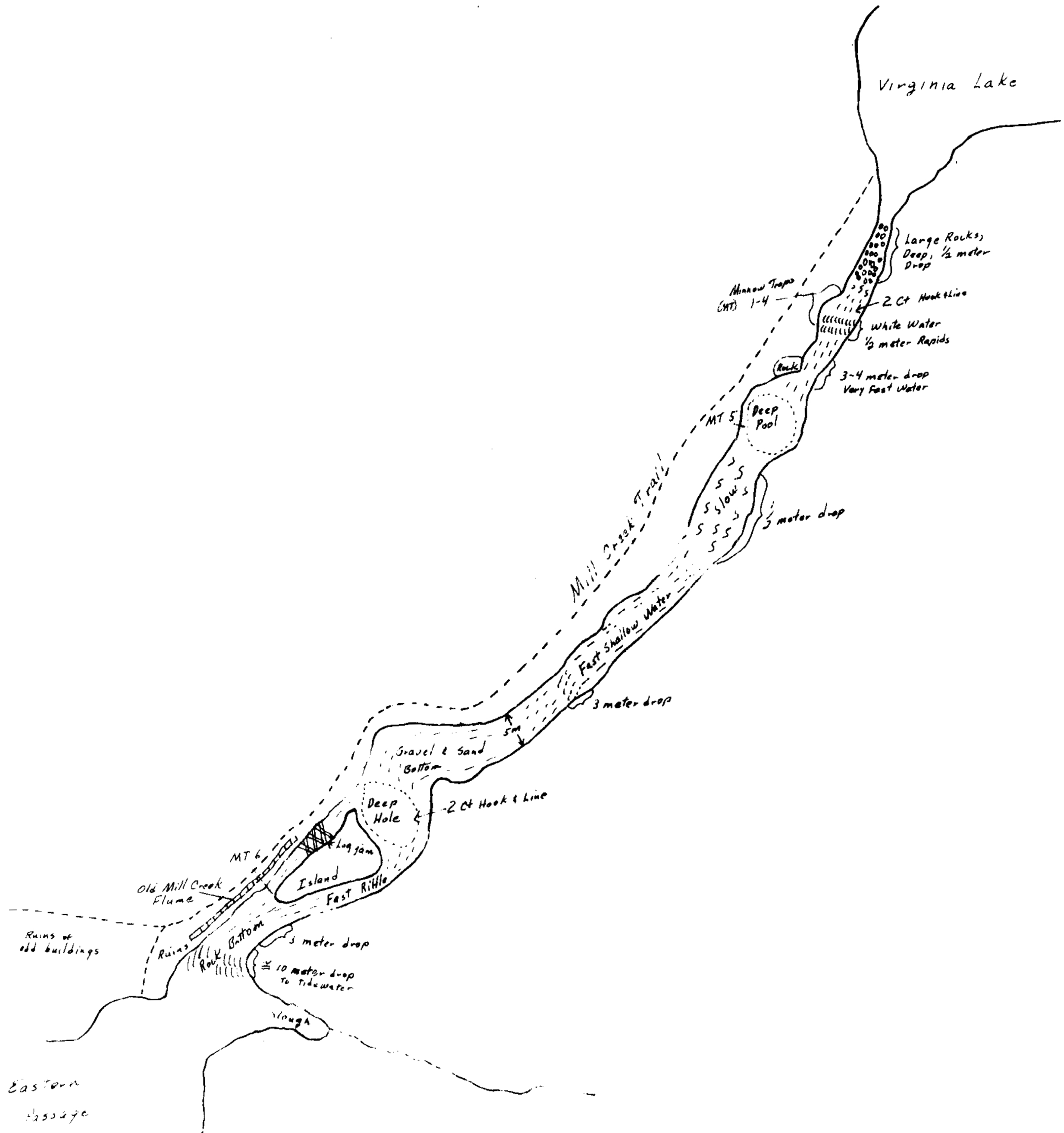


Figure 23. Map of Mill Creek.

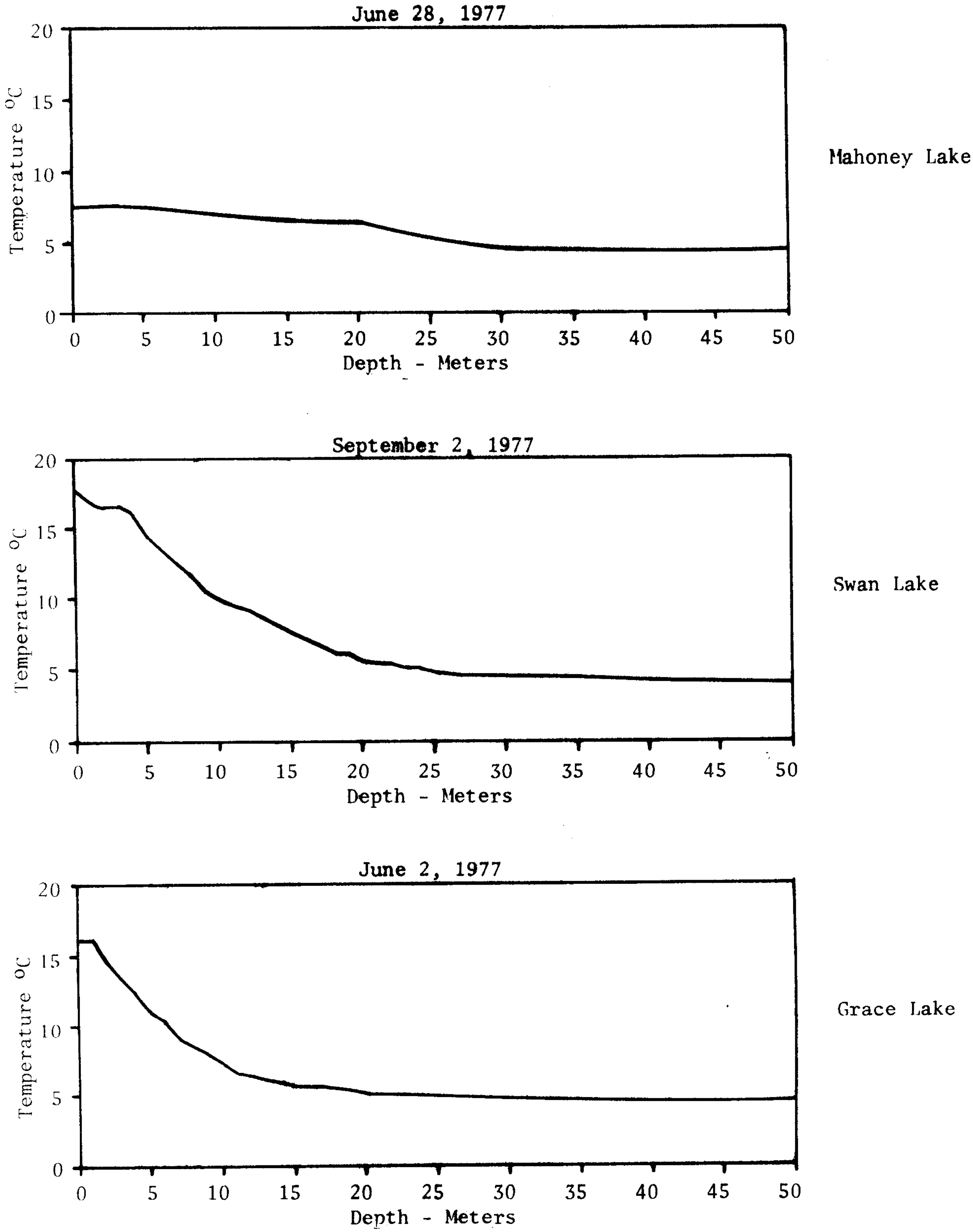


Figure 24. Thermal profiles of Grace, Mahoney, and Swan lakes, 1977.

Table 7. Alkalinity, conductivity, and pH of lakes studied, 1977.

Lake	Alkalinity ($CaCO_3$) (mg/1)	Conductivity (micromhos)	pH
Grace	4.0	9.0	5.9-6.4
Mahoney	4.0	45.0-85.0	5.9
Swan	6.8	ND*	6.2-6.5
Virginia	9.0	19.0	6.7

*Not determined.

Table 8. Plankton composition and density (organisms per square meter) as collected with No. 153 and No. 80 Nitex plankton nets, Mahoney and Swan lakes, 1977.

Lake	Mahoney		Swan	
Date	June 28	June 28	August 31	August 31
Depth of Tow (m)	70	70	100	100
Mesh Size	153	80	153	80
Copepoda				
Calanoida				
Diaptomus sp.	25,959	11,198	4,072	2,036
Cyclopoida	12,725	6,617	21,037	9,162
Nauplii			7,803	12,725
Cladocera				
Bosmia sp.	57,517	20,615	56,667	35,630
Daphnia sp.	1,018		22,737	7,635
Holopedium sp.			1,018	
Polyphemus sp.			3,395	1,018
Scapholebris sp.			1,359	
Rotatoria				
Asplancha sp.			1,359	1,527
Kellicottia sp.	15,779	16,288	27,486	102,309
Keratella sp.		5,345		4,581
Miscellaneous			1,422,400	1,821,711

Table 9. Identification and enumeration of stream drift organisms, inlets to lakes, 1977.

Lake	Grace	Mahoney			Virginia		Swan
Date	June 14	June 29	June 30	August 3	July 19	July 21	September 1
Number of Nets	1	1	1	1	2	2	1
Oligochaeta		1	4				
Arachnida					2	2	
Hydracarina					23	3	
Insecta							
Ephemeroptera							
Ameletus sp.	4	1	1	8	5		
Baetis bicaudatus	10	33			41	22	
B. intermedius	1				1		
B. tricaudatus					6		
Baetis sp.					13		2
Cinygmula sp.		1			7	1	
Epeorus sp.					14	11	
Ephemerella sp.						3	
Paraleptophlebia sp.					4	1	
Rhithrogena sp.					1		
Plecoptera							
Alloperla sp.	3			22	3		
Capnia sp.		2					
Leuctra augusta					1	1	
Zapada sp.		8		4	9	1	
Tricoptera							
Limnephilidae				2			2
Diosmoecus sp.		1					
Rhyacophilidae							
Rhyacophila sp.		1					
Diptera							
Chironomidae							
Larvae	1				1	8	
Brillia sp.						1	
Corynoneura sp.						1	5
Cricotopus sp.				4			
Heterotrissocladius sp.		28	10				
Orthocladius sp.	1						
Phaenopsectra sp.			2				
Pseudodiamesa c.f. *arctica*		10	2	10			
Chironomidae							
Adults and Pupae		3		121	1	4	
Anthomyiidae				1			2
Deuterophlibiidae							
Deuterophlebia sp.						2	
Empididae				5		7	
Mycetophilidae						1	
Rhagionidae				3			
Simulidae	3	1			4	1	
Tabanidae				1			
Tipulidae		2	1	1			
Coleoptera							
Staphylinidae		1		2			
Scolytidae							
Dendroctonus sp.			1				
Tenebrionidae						1	
Homoptera							
Aphidae				1			
Hymenoptera		1		1		1	
Chalcidae						1	
Lepidoptera						2	

Fish

Rearing and resident fish were sampled by gill net, fry traps, and hook and line. Mean length and weight of Dolly Varden, Salvelinus malma (Walbaum), by lake and age group are presented in Table 10. Mean length and weight of kokanee, Oncorhynchus nerka (Walbaum), by age group are shown in Table 11. Length and weight of cutthroat trout, Salmo clarki Richardson, by age class is summarized for cutthroat trout from Virginia Lake in Table 12. Length and weight of brook trout, S. fontinalis (Mitchill), from Grace Lake are listed in Table 13. Condition factors for all species are presented in Table 14. Fry trap catches for inlets to all lakes are summarized in Table 15.

Stomach contents of kokanee from Mahoney, Swan, and Virginia lakes were examined and enumerated in Table 16. Chironomidae were by far the most abundant food items occurring in 93% of stomachs which contained food.

Stomach content analysis of cutthroat trout from Virginia Lake is presented in Table 17. The most common food items were chironomidae (82%) and small fish (45%) occurring in stomachs sampled.

Stomach content analyses from brook trout in Grace Lake, and Dolly Varden in Swan Lake, are presented in Tables 18 and 19. Chironomidae were the most common food item of brook trout. Dolly Varden in Swan Lake ate whatever invertebrates were available. No fish remains were found, indicating that Dolly Varden are not utilizing the kokanee as food.

Evaluation of Lakes for Recreation and as Hydroelectric Sites

Grace Lake:

Grace Lake (55°39' N, 130°3' W) is located on Revillagigedo Island approximately 48 kilometers (30 air miles) from Ketchikan. Surface elevation is 132.6 meters (435 feet) above sea level. Surface area is 660.3 hectares (1,631 acres). The lake has a maximum depth of 140 meters near the center of the large bowl and a mean depth of 61.5 meters. Access to the lake is via floatplane. There are no facilities on the lake.

The main inlet to the lake is accessible to fish for about 4.8 kilometers (3 miles). Discharge is about 100 cfs. The stream is an ideal habitat with deep pools and backwater sloughs formed by beaver dams.

The inlet delta is characterized by a flood plain ecosystem with mudflats, grasses, backwater ponds, and a few beaver sloughs. It is ideal waterfowl habitat, as evidenced by the number of birds frequenting the area. A flock of Canadian honkers, several mallards, goldeneye, and mergansers were seen. Nesting mew gulls were seen atop trees near the stream mouth.

Above the delta the stream has free-flowing, clear water with a substrate of sand, pebble, and small rocks approximately 15 centimeters in diameter. The banks are from 1 to 3 meters in height covered by berry bushes,

Table 10. Mean length and weight of Dolly Varden by age class, Mahoney, Swan, and Virginia lakes, 1977.

Age	Number	$\bar{x}$ Length	Range	Standard Deviation	$\bar{x}$ Weight	Range	Standard Deviation
				Mahoney Lake			
5	3	126	120-135	7.9	21.0	10-30	10.2
8	1	285			200.0		
				Swan Lake			
2	2	122	120-125	3.5	16.5	15-18	2.1
3	3	135	130-140	5.0	24.0	20-30	5.3
4	1	166			50.0		
5	3	194	187-200	6.5	65.0	60-70	5.0
6	1	203			170.0		
				Virginia Lake			
3	1	120			15.0		
4	1	172			50.0		
5	1	171			50.0		
6	1	168			49.0		

Table 11. Mean length and weight of kokanee by age class, Mahoney, Swan, and Virginia lakes, 1977.

Age	Number	$\bar{x}$ Length	Range	Standard Deviation	$\bar{x}$ Weight	Range	Standard Deviation
				Mahoney Lake			
4	17	219		18.0	121		12.4
				Swan Lake			
2	1	175			53		
3	2	167	162-172	7.1	55	50-60	7.1
4	5	177	165-190	12.6	55	40-70	11.7
				Virginia Lake			
1	2	114	114-115	0.7			
2	3	146	145-148	1.5			
3	18	186	174-205	8.4			
4	6	204	185-225	14.3			
5	1	220					

Table 12. Age, length, and weight of cutthroat trout, Virginia Lake, 1977.

Age	Number	$\bar{x}$ Length (mm)	Range	Standard Deviation	$\bar{x}$ Weight (gm)	Range	Standard Deviation
2	1	125			17		
3	5	155	128-178	19	34	29- 49	12
4	2	178	172-185	9	50	41- 59	13
5	8	211	182-227	21	87	55-120	22
6	4	233	205-257	22	120	78-153	36
7	4	300	275-318	19	300	275-318	19
10	1	330			319		
13	1	437					

Table 13. Age, length, weight, and condition factor (K)* of brook trout, Grace Lake, 1977.

Age	Length (mm)	Weight (gm)	K*
2	110	20	1.50
4	210	120	1.30
4	252	160	1.00
5	282	130	0.58
5	222	110	0.91
5	257	160	0.94
5	260	195	1.11
5	235	140	1.08
7	342	400	1.00

$$*K = \frac{100 \times \text{Weight (gm)}}{\text{Fork Length (cm)}^3}$$

Table 14. Condition factors (K)* of Dolly Varden, kokanee, and cutthroat trout from lakes studied, 1977.

Lake and Species	Number	Condition Factor $\bar{x}$	Range	Standard Deviation
Mahoney,				
Dolly Varden	4	1.1	0.4-1.6	0.5
Kokanee	17	1.2	0.8-1.6	0.2
Swan,				
Dolly Varden	10	1.0	0.9-2.0	0.4
Kokanee	8	1.0	0.9-1.2	0.1
Virginia,				
Dolly Varden	4	1.0	0.9-1.0	0.1
Kokanee	13	1.0	0.9-1.1	0.1

Table 15. Summary of fry trap catches by lake and location for lakes studied, 1977.

Lake and Date	Location	Number of Traps	Total Catch
Grace,			
June 14	Main Inlet	8	0 Fish
Swan,			
August 31	4 Minor Inlets	6	10 DV (39-131 mm)
September 1	Main Inlet	5	10 DV (33-89 mm), 12 CD
Virginia,			
July 20	Glacier Creek	5	0 Fish
July 21	Lake Shore	5	3 CT, 2 DV, 3 CD
Mahoney,			
June 6	Both Inlets	18	18 DV (72-130 mm)
June 23	Outlet	6	2 Rb, 2 CT, 13 DV
August 2	West Inlet	8	100 DV (53-114 mm)

Table 16. Stomach contents from kokanee - Mahoney, Swan, and Virginia lakes, 1977.

Lake	Mahoney																		Swan					Virginia						
Fish Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	1	2	3	4	5	1	2	3	4	5	6	7
Length (mm)	215	230	212	210	212	233	200	212	240	255	233	212	242	228	202	193	230	192	176	175	195	172	165	200	?	210	212	220	196	145
Cladocera																						9,000	2,500							
Arachnida																			1					1						
Insecta																														
Ephemeroptera																														
Baetidae																									3				16	
Heptageniidae																													1	
Plecoptera																	1								1			1		
Tricoptera				3											3	1			3		6					3			1	
Diptera							3									3			2											
Chironomidae		12			3	35	9	49	32		16	7	17	10	2	13	94	3	53	5	3			16	2	1	6	4	5	2
Empididae								1			1													1						
Muscidae																								1						
Simulidae											2																			
Tipulidae												1																		
Coleoptera																			3		1		1		2			1		
Dytiscidae																			1		1									
Staphylinidae														1										2					2	
Hemiptera																			2											
Hymenoptera									1										4		4			6						
Chalcidae																								1						
Lepidoptera								1					1																	

Table 17. Stomach contents from cutthroat trout, Virginia Lake, 1977.

Fish Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Length (mm)	236	240	275	257	263	203	297	208	182	156	183	185	128	125	437	318	310	216	167	172	178	148
Sex	F	M	F	M	F	F	F	M	F	M	F	F	F	M	F	M	F	M	M	F	F	F
Arachnida			1													1					1	
Insecta																						
Ephemeroptera					2																	
Baetidae	14	1			5				2					16								
Heptageniidae					1		1															
Tricoptera																						
Leptoceridae																				1		
Limnephilidae			5	1					1					1				2		1	6	4
Molanidae													2									
Rhyacophilidae	1																					
Diptera																						
Chironomidae	1	1	1	1	2			1	1	1	8	1		2/	1	8		1	1	10	3	1
Anthomyiidae																3				1		
Empididae								1								4		2	1	2	11	
Simulidae	1													2							1	
Syrphidae																1						
Coleoptera								1												3	5	
Homoptera																						
Aphididae														15								
Cicadellidae																1						
Hymenoptera																5				5	5	
Ichneumonidae																1	61					
Lepidoptera																		1				
Geometridae																1						
Gastropoda				7													70					
Fish		3			3	2	2	1		34	1	1			1				1			
Eggs			570						2													

Table 18. Stomach contents from brook trout, Grace Lake, 1977.

Fish Number	1	2	3	4	5	6	7	8	9
Length (mm)	222	235	282	210	342	110	260	252	257
Sex	M	F	F	M	F	F	M	M	F
Nematoda			1						
Oligochaeta		1							
Cladocera						300			
Hydracarina						1			
Insecta									
Ephemeroptera						1			
Plecoptera							1		
Tricoptera							2	6	1
Limnephilidae	2	5	9			1			
Diptera									
Chironomidae		2		540		15	34	12	2
Bibionidae							1		
Coleoptera									2
Dytiscidae						1			
Staphylinidae							10		
Hymenoptera								1	
Lepidoptera								4	
Odonata									1
Gastropoda	34			1					

Table 19. Stomach contents from Dolly Varden, Swan Lake, 1977.

Fish Number	1	2	3	4	5	6	7	8	9
Length (mm)	180	200	187	140	166	120	203	130	136
Sex	M	F	F	?	?	?	M	?	?
Cladocera		1,600							
Arachnida		1				1			
Insecta									
Ephemeroptera						1			
Heptageniidae						1			
Trichoptera									
Limnephilidae							5		
Diptera		3							
Chironomidae			2					16	
Coleoptera							2		
Hymenoptera		9							
Molluska				1					
Gastropoda	15			23					

alder, and spruce with an occasional muskeg. Approximately 3 kilometers (2 miles) from the mouth, the stream flows through a scenic meadow which is bordered by mountainsides, a very picturesque setting. Beaver inhabit the area; fresh cuttings, dams, and mud piles were abundant. Wolf and black bear signs were seen.

The outlet from the lake, Grace Creek, was not surveyed during this investigation. It flows about 4 kilometers (2.5 miles) to Behm Canal. Grace Creek is blocked by a 12 meter (40-foot) falls about 0.8 kilometers (0.5 mile) below the lake. The area below the falls is used by pink, chum, and coho salmon.

The only fish inhabiting the lake are brook trout, which were planted by the U.S. Forest Service in 1932. The largest fish captured during this survey was 342 millimeters and weighed 400 grams. Fish were observed feeding at the lake surface in the evening.

The lake is very scenic with mountains and heavy forests bordering the shores. It receives very little fishing pressure from residents of Ketchikan. Recreational uses may come from deer and bear hunting. Any improvement of the sport fishery would greatly enhance the lake's popularity.

A more thorough investigation of lake limnology would be needed prior to any future fish plants. Cabin sites are available near the inlet delta, and a scenic trail could be built up the main inlet.

Development as a hydroelectric site would not impact a major sport fishery. Development would, however, eliminate a large portion of the 5 kilometer (3+ mile) inlet stream. A dam could also alter the temperature and streamflow of Grace Creek, which would be hazardous to salmon spawning and rearing.

Upper Mahoney Lake:

Upper Mahoney Lake (55°25'15" N, 131°31'15" W) is an alpine lake fed by snowmelt. The lake has a maximum depth of 71 meters. It has a horseshoe-shaped basin with a surrounding watershed consisting of rolling alpine meadows covered with moss, lichens, granitic bedrock exposed by erosion, yellow cedar, and scrub spruce, all of which is interspersed with snowpack. Access to Upper Mahoney Lake is primarily via helicopter from Ketchikan; air time is approximately 20 minutes.

The lake has two inlets. The main inlet enters the lake from the southwest. Streamflow measured 40 cfs in August. This inlet has a 50% waterfall and a 50% pool ratio with an average depth of 0.6 meters (2 feet). The substrate consists of bedrock with portions being large, flat, eroded rocks. Its source of water is a small, snow-fed lake 400 meters southwest and 152 meters (500 feet) above the Upper Mahoney Lake surface. The second inlet contributed 15 cfs during August. Both these streams were fry trapped to determine the presence of any rearing fish. Neither stream yielded any fish.

No fish were found by gill-netting and fry trapping. Arctic grayling, Thymallus arcticus (Pallas), planted in 1969 evidently did not survive.

The lake was very clear with a Secchi reading of 30 meters. Two 24-hour drift net sets were made in the inlet, which yielded a rich supply of chironomid larvae. Approximately 300 insects were captured.

Development of the Mahoney lakes area for hydroelectric power would have little effect on any existing sport fishery. It would, however, eliminate what remains of the sockeye salmon, O. nerka (Walbaum), run and endanger the small steelhead trout, S. gairdneri Richardson, population.

Swan Lake:

Swan Lake (55°37' N, 131°17' W) is located on Revillagigedo Island on the eastern shore of Carroll Inlet. It is a large lake with a maximum depth of 153 meters and a surface area of 404.9 hectares (1,000 acres).

The lake is fed by four inlets with the majority of flow coming from a large stream located at the northeast head of the lake. A flow of 30.49 cfs was measured at this stream during a period of drought. The other inlets averaged a flow of 1.3 cfs. The lake showed the effects of the dry spell with large areas of exposed mudflats at the head of the lake.

The main inlet had ample spawning gravel throughout the distance surveyed, approximately 500 meters. The stream had many blowdowns from the mouth upstream, approximately 200 meters, which provided many holes 3 to 5 meters deep and backwater pools ideal for rearing fish. Much of the streambank was undercut 0.6 to 0.9 meters (2-3 feet), creating eddies and shallow pools.

The minor tributaries were void of spawning gravel due to their steep grade and bedrock substrate. These streams were short, none being longer than 100 meters.

Animal sign observed in the inlet area included black bear, deer, wolf, and beaver. Flocks of Canadian geese and mallards were using the inlet delta.

Falls Creek, the outlet from Swan Lake, was not surveyed but is blocked by a waterfall near tidewater.

Fish inhabiting the lake include Dolly Varden and kokanee, O. nerka (Walbaum). Brook trout were planted in 1931, but the introduction was unsuccessful. No evidence of the presence of cutthroat trout was observed, although an earlier report stated the presence of cutthroat trout.

Fishing pressure on the lake is very low, if present at all. The Dolly Varden are not feeding on the kokanee. The only pressure the lake receives is from hunters. There are no facilities on the lake. Campsites are few except for the main inlet area.

Development of this lake as a hydroelectric site would have no effect upon an existing sport fishery. The presence of kokanee and ample spawning area for cutthroat trout would allow the development of a cutthroat trout/ kokanee complex. This potential will be eliminated if developed as a hydroelectric site.

Virginia Lake:

Virginia Lake (56°28'45" N, 132°10'00" W) is located at the edge of the Coast Mountains, 12.9 kilometers (8 miles) east of Wrangell. Virginia Lake has a surface area of 257.5 hectares (636 acres), a maximum depth of 57 meters, and lies at elevation of 32 meters (105 feet).

Access to Virginia Lake is by floatplane or by a trail up Mill Creek, the outlet stream, from salt water. The trail is in good shape and provides easy access to Mill Creek.

Facilities include a U.S. Forest Service cabin and skiff at the head of the lake and a skiff at the trailhead by the Mill Creek outlet. The cabin is a new style panabode with oil stove.

The two main inlets are Porterfield and Glacier creeks. Both are low gradient with small gravel and sand. They appear to be ideal sockeye salmon streams. Streamside vegetation includes much devils club. Overstory is of spruce, hemlock, and alder. The first 3.2 kilometers (2 miles) of Porterfield Creek are meandering with split channels and gravel substrate. The upper section is faster water with rocky streambed. Stream walking is difficult due to blowdown timber and log jams.

Moose and wolf tracks were seen in Porterfield Creek. Geese were using the lake and inlets during the summer molt.

Virginia Lake has an excellent cutthroat trout fishery. Its proximity to Wrangell and easy access make it a very popular site. Most of the lake shoreline is steep sided with overhanging trees. There are large shallow deltas off each of the inlets. Casting from a boat toward shore and under overhanging trees is a sure method of catching fish. Larger cutthroat trout are obtained by trolling near the steep banks.

Other fish species include sockeye salmon; kokanee; Dolly Varden; threespine stickleback, *Gasterosteus aculeatus* Linnaeus; and cottids. A substantial sockeye salmon subsistence fishery occurs at the outlet of Mill Creek. The sockeye salmon in this system are unique, as they are small fish. They have probably been selectively bred for smaller size by the precipitious falls on Mill Creek, which will not allow passage of larger fish. Brook trout were planted in the lake in 1931 by the U.S. Forest Service. No brook trout were taken during this investigation.

Development of Virginia Lake for hydroelectric generation would have definite detrimental effects on a very valuable sport fishery. Construction of a dam and raising of the lake level would (1) eliminate a unique sockeye salmon population and the fishery on it; (2) eliminate most, if not all, of the spawning area in Glacier and Porterfield creeks; (3) eliminate the littoral area of the lake; (4) cause undetermined harm to the lake's cutthroat trout and kokanee populations; and (5) flood the recreational cabin.

LITERATURE CITED

Schmidt, A.E. and Robards, F.S. 1973. Inventory and cataloging of the sport fish and sport fish waters in southeast Alaska. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1972-1973, Proj. F-9-5 (14(G-I-A). 62 pp.

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